APPENDIX G

Operation and Maintenance Plan for Groundwater Control Operable Unit dated March 2003

WASTE MANAGEMENT OF WISCONSIN, INC.

OPERATION AND MAINTENANCE PLAN FOR GROUNDWATER CONTROL OPERABLE UNIT

CITY DISPOSAL CORPORATION LANDFILL
DUNN, WISCONSIN

MARCH 2003

ARCADIS
Infrastructure, buildings, environment, communications

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Operation and Maintenance Plan for Groundwater Control Operable Unit

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1. Introduction

This Operation and Maintenance (O&M) Plan has been prepared by ARCADIS in accordance with the reporting requirements specified under Section III of the Statement of Work (SOW), Attachment B to the Unilateral Administrative Order (UAO) for the Remedial Design and Remedial Action specific to the Groundwater Control Operable Unit at the City Disposal Corporation Landfill in Dunn, Wisconsin (U.S. Environmental Protection Agency [U.S. EPA], 1993). The UAO is between the Respondent, U.S. EPA and Wisconsin Department of Natural Resources. The O&M Plan describes the procedures to be followed for ensuring effective operation and maintenance of the Groundwater Control Operable Unit remedy, which is one of the selected response action activities identified in the SOW. The objective of the Groundwater Control Operable Unit remedy is to provide hydraulic containment of the more contaminated portions of the groundwater plume near the site. Extracted groundwater collected as part of this system operation will be treated and discharged to Badfish Creek. Drawing C-2 presents the site plan. Refer to Appendix B of this plan for all referenced As-built Drawings.

Vendor supplied O&M literature on the various equipment items that comprise the extraction and treatment system have been incorporated into a bill of materials. The bill of materials, vendor contacts, and equipment cut sheets are presented in Appendix A. As-Built drawings are presented in Appendix B.

2. Description of the Groundwater Control Operable Unit (GCOU)

The GCOU has been designed to capture and treat groundwater in the vicinity of the site that has the highest concentrations of the contaminants of concern. The GCOU was retrofitted in August 2002 to a lead/lag bioreactor configuration. No major equipment was added during retrofit activities (existing equipment was either modified or taken out of service). The system consists of three groundwater extraction wells, a below grade force main conveyance piping network, and a treatment system that incorporates the following major components (retrofit activities are denoted in bold typeface):

1. Influent Equalization Tank for dampening fluctuations in groundwater extraction pumping rates. **The Influent Equalization Tank was converted to a polishing bioreactor (Lag Fixed-Film Bioreactor) in August 2002 to increase the throughput and treatment efficiency of the GCOU system.**

2. Influent Pump to transfer the contents from the Influent Equalization Tank to the Fixed-Film Bioreactor. **The Influent Pump was taken out of service during the August 2002 retrofit.**

3. Fixed-Film Bioreactors as the means for organic contaminant removal.

4. Inclined Plate Clarifier for removal of biological solids and precipitated metals exiting the bioreactor.

5. Chemical feed system for metering biomass growth nutrients to the bioreactor.

6. Chemical feed system for metering a surrogate carbon substrate to the bioreactor during startup and during system upsets.

7. Aeration Blower and fine bubble diffuser system for mixing and oxygenating the contents of the bioreactor. **An additional aeration line was connected to the blower to supply aeration air to the Lag Fixed-Film Bioreactor (formerly Influent Equalization Tank).**

8. Sump pump to return water collected in the sump crock from spills or minor leaks into the Lag Fixed-Film Bioreactor.

9. Instrumentation and controls designed for remote operation and control of the system. The instrumentation and controls will store key operational data (e.g., motor run times, temperature, flow rate, etc.) for retrieval remotely via telephone lines and a personal computer equipped with a modem.

10. A pre-engineered building to house the equipment described above.

11. Solids Storage Tank for intermediate holding of the thickened solids produced by the clarifier.

12. A below grade discharge line to convey treated effluent from the Groundwater Control Operable Unit to an outfall located in an on-site grass lined swale that discharges into an on-site wetlands which subsequently drains to Badfish Creek.

13. A below grade force main to convey treatment system influent from the extraction wells to the treatment building.

The recovery wells have been located in the concentrated regions of the plume to provide hydraulic containment of groundwater which has contaminant concentrations greater than applicable standards. These standards have been defined in the Record of Decisions to be the Preventive Action Limits established in Chapter NR 140, Wisconsin Administrative Code.

A detailed description of the groundwater recovery and treatment system is presented in the Final Construction Completion Report (ARCADIS, 2003) and in the following sections. In addition, the details of the groundwater extraction and treatment system are illustrated on the Piping and Instrumentation Diagrams (P&IDs) included as Drawings PID-1 through PID-5 (Appendix B). Note that the equipment designations identified in the text of the O&M Plan match the equipment designations identified on the P&IDs and as-built drawings.

2.1 Groundwater Extraction

The groundwater extraction system consists of three components: 1) extraction wells, 2) extraction pumps, and 3) groundwater conveyance force mains. Drawings C-1 and C-2 shows the location of these components.

2.1.1 Groundwater Extraction Wells (EW-301, EW-302 & EW-303)

The extraction wells (EW-301, EW-302, and EW-303) each consist of a 6-inch diameter, type 304 stainless steel riser pipe, a 6-inch diameter type 304 stainless steel well screen, and a submersible well pump (P-301, P-302, and P-303). Specific information for each of the extraction wells is summarized as follows:

1. EW-301: The top of the well screen is set approximately 22.5-feet below grade. The well screen is 50-feet long. The bottom of the well is 72.5-feet below grade. The above-grade section of the well and the associated well head piping are housed in an approximate 3-foot diameter corrugated metal pipe (CMP) vault with bolted steel lids. The well vault housing extends approximately 2-feet above grade. Valves for adjustment of flow rate from each well and the flow meter for volumetric recording are located in the treatment building.

2. EW-302: The top of the well screen is set at approximately 22.5-feet below grade. The well screen is 30-feet long. The bottom of the well is located 52.5-feet below grade. The above-grade section of the well and the associated well head piping are housed in an approximate 3-foot diameter CMP vault with bolted steel lids. The well vault housing extends approximately 2-feet above grade. Valves for flow rate adjustment and the flow meter for volumetric recording are located in the treatment building.

3. EW-303: The top of the well screen is set at approximately 26-feet below grade. The well screen is 30-feet long. The bottom of the well located 56-feet below grade. The above-grade section of the well and the associated well head piping are housed in an approximate 3-foot diameter CMP vault with bolted steel lids. The well vault housing extends approximately 2-feet above grade. Valves for flow rate adjustment and the flow meter for volumetric recording are located in the treatment building.

2.1.2 Groundwater Extraction Pumps (P-301, P-302 & P-303)

EW-301 and EW-302 are each equipped with a ½ HP, 240 VAC, single-phase submersible turbine pump, designated as P-301 and P-302, respectively. EW-303 is equipped with a 1/3 HP, 240 VAC, single-phase submersible turbine pump, designated as P-303. Drawing PID-3 provides more information on the pumps.

2.1.3 Groundwater Conveyance Force Main

A buried 2-inch diameter high-density polyethylene (HDPE) forcemain, is utilized to convey the recovered groundwater from the extraction wells to the treatment building. The force main has been installed at least 42-inches below grade to ensure that it is positioned below the depth of frost penetration. The force main is approximately 3,150 feet in length.

2.2 Groundwater Treatment

The following sections present detailed descriptions of the major components of the groundwater treatment system. Drawings PID-1 and PID-2 show the process and instrumentation for the treatment system.

2.2.1 Lag Fixed-Film Bioreactor (T-101) [Formerly Influent Equalization Tank]

2.2.1.1 Original Configuration

Tank T-101 has a nominal volume of 3,000 gallons. Nominal tank dimensions are 8-foot diameter by 8.83-feet high. The material of construction is cross-linked high density polyethylene with a 130 Fahrenheit (°F) maximum temperature limit. The design pressure of the tank is atmospheric. The tank was originally designed for dampening of flow variations (and intermediate storage) of groundwater from the GCOU extraction wells. The holding tank is equipped with four float type level switches.

2.2.1.2 August 2002 Retrofit

The existing influent tank was converted to serve as a polishing bioreactor vessel (Lag Fixed-Film Bioreactor) in August 2002. One 3-inch aeration header with 10¾-inch diffusers was installed. Media supports were then installed in the bottom of the tank and a 4-foot layer of corrugated plastic media was installed. The effluent piping from the Lag Fixed-Film Bioreactor vessel was routed to the clarifier influent port, for gravity discharge. Tank level controls were modified to only incorporate high- and low-liquid level alarms.

2.2.2 Influent Pump (P-101)

2.2.2.1 Original Configuration

Influent Pump P-101 is a close-coupled centrifugal pump rated for 25 gallons per minute (gpm) at 10 feet of water column (w.c.) total dynamic head (TDH). The pump is driven by a ¼ HP, 1800 revolutions per minute (RPM), TEFC motor (230 VAC, 1 Ph., 60 Hz.). Pump and motor casing are constructed of cast iron. The pump inlet and outlet connections are 1¼ inch and 1 inch, respectively.

The influent pump is designed for continuous operation and is used to transfer the contents of Tank T-101 into the Tank T-102. Interlocking controls have been designed such that the pump is automatically shut down under a general alarm condition system trip.

2.2.2.2 August 2002 Retrofit

The influent pump and electrically actuated recycle/forward flow control valves were taken out of service during the August 2002 retrofit converting the GCOU to a lead/lag bioreactor system.

2.2.3 Lead Fixed-Film Bioreactor (T-102)

2.2.3.1 Original Configuration

Tank T-102 vessel has a nominal capacity of 4,500 gallons. The nominal dimensions of the vessel are 9-foot diameter by 10-feet high. The material of construction is carbon steel with coal tar epoxy lining on the vessel interior and an enamel finish on the exterior. The design pressure of the tank is atmospheric. Vessel internals consist of an influent distribution header, an effluent collection header (underdrain), approximately 380 cubic feet of corrugated media (packing), and packing supports. Vessel internals are constructed of polyvinyl chloride (aeration diffuser laterals, packing) and carbon steel (packing supports). The Lead Fixed-Film Bioreactor is equipped with two float type level switches.

The Lead Fixed-Film Bioreactor T-102 is designed for continuous operation. Groundwater enters at the top of the vessel and is distributed uniformly in a down-flow configuration via distribution laterals with a number of evenly spaced orifices. The groundwater flows downward through 6 feet of corrugated packing. The packing

serves as a support media for growth of biomass and promotes even distribution of the influent groundwater. Aqueous phase organic constituents are transferred from the groundwater into the biofilm where they are metabolized by the microorganisms to form carbon dioxide, water, and biomass. Air is introduced at the bottom of the vessel via fine bubble diffusers. Treated effluent is collected near the bottom of the vessel via the underdrain.

2.2.3.2 August 2002 Retrofit

The groundwater influent header pipe attached to the three recovery wells was re-routed to discharge into the bioreactor tank through the existing influent piping (thus utilizing the existing valves and magnetic flow meter). Strainers were installed in each of the influent groundwater header pipes to filter out particles larger than 40-mesh. The bioreactor tank effluent piping was re-routed to gravity discharge into the existing influent tank (Lag Fixed-Film Bioreactor T-101).

2.2.4 Inclined Plate Clarifier (T-201)

The inclined plate clarifier is rated at an overflow rate of 0.50 gallons per minute/cubic foot effective area when operated at the design flow rate of 25 gpm. The clarifier tank shell and baffles are constructed of A-36 carbon steel. External structural members are carbon steel. The settling plates are constructed of fiberglass reinforced plastic. Plate spacing is 2¼ inches. Plates are inclined at a 60° angle to enhance settling. Plate packs are removable for servicing.

Influent enters the plate separator through an inlet nozzle and discharges into a flow distribution zone located across the width of the separator. Flow is directed downward, under the parallel plates, then up through the spaces between the plates. Clear supernatant enters the clean water outlet chamber by cascading over an adjustable weir. The weir runs the full length of the clarifier to further insure even flow distribution throughout the plate pack.

Solids settle on the parallel plates and slide down the plates into a sludge-collecting hopper.

2.2.5 Carbon Substrate Feed System (T-104, CMP-104)

The Carbon Substrate Feed Pump (CMP-104) is a Liquid Metronics Series P or equal (microprocessor based, solenoid driven, diaphragm, automatic priming, 115 VAC/1

phase/60 Hz.). Materials of construction for wetted parts are polypropylene head and fittings, ceramic balls, and polyprel seals. The nominal carbon substrate feed rate is expected to be 4.0 milliliters per minute (based on a water flow rate of 25 gpm).

The operation of the Carbon Substrate Feed Pump will be based on a user selectable timer via the operator interface. Flowrate will be manually set at the pump driver by adjusting the stroke length and frequency. Interlocking controls have been designed such that the Carbon Substrate Feed Pump is automatically shut down under a general alarm condition system trip.

The Carbon Substrate Feed Tank (T-104) is a 55-gallon drum. Tank T-104 will be used to hold the surrogate carbon source to be used for initial seeding of the reactor and for maintaining a viable bacterial population in the event the groundwater extraction system is down for significant periods of time. It is mixed with water at an approximate dilution ratio of 2 to 3 (2 gallons of syrup to 3 gallons of water). This mixed solution is then injected via the Carbon Substrate Feed Pump.

2.2.6 Nutrient Feed System (T-105 & CMP-105)

The Nutrient Feed Pump (CMP-105) is a microprocessor based, solenoid driven, diaphragm, automatic priming, 115 VAC/1 phase/60 Hz. Materials of construction for wetted parts are polypropylene head and fittings, ceramic balls, and polyprel seals. The nominal nutrient feed rate is expected to be 4.0 milliliters per minute (based on a design groundwater flow rate of 25 gpm).

The operation of the Nutrient Feed Pump will be based on a user selectable timer. Flowrate will be manually set at the pump driver by adjusting the stroke length and frequency. Interlocking controls have been designed such that the Nutrient Feed Pump is automatically shut down under a general alarm condition system trip.

The Nutrient Feed Tank (T-105) is a 55-gallon drum. Tank T-105 will be used to hold the nutrient solution to be used to support biomass growth. The solution will contain approximately 20 percent nitrogen and 4 percent phosphorous prepared using urea, ammonia, phosphoric acid, and water.

2.2.7 Aeration Blower (B-102)

Aeration Blower B-102 is a positive displacement blower used to provide pressurized air to the bioreactor's diffusers. The blower will include a 3 HP, 3600 RPM, TEFC

motor (230 VAC, 1 Ph., 60 Hz.), inlet and outlet silencers, inlet air filter, sheaves, belt, and belt guard. The blower system was sized for an air flowrate of 40 scfm at a discharge pressure of 6 pounds per square inch.

The blower system is designed for continuous operation. Interlocking controls have been designed such that the blower system is automatically shut down under a general alarm condition system trip.

2.2.8 Solids Storage Tank (T-202)

Solids Storage Tank T-202 has a nominal capacity of 3,000 gallons. Nominal tank dimensions are 6 feet 1-inch diameter by 14 feet in length. The tank is equipped with two 16 inch manway hatches, three 2 inch FNPT bungs, and one 4 inch American National Standards Institute Class 150 flange. The material of construction is 3/16-inch thick carbon steel (heads are ¼-inch thick) with a 170 °F maximum temperature limit. The design pressure of the tank is atmospheric.

Thickened solids flow by gravity from the Inclined Plate Clarifier T-201 sludge chamber to the Solids Storage Tank T-202. Solids removal will occur via vacuum truck from two hatches located on top of the tank at each end.

2.2.9 Sump Crock/Sump Pump (P-201)

Sump Pump P-201 is a 115 VAC pump able to pump approximately30 gpm at 12 feet w.c. TDH. P-201 is equipped with an integral mercury switch to enable/disable operation of the pump. The purpose of the sump pump is to return collected water from nuisance leaks (e.g., sample port left open) into Lag Fixed-Film Bioreactor T-101.

The sump crock dimensions are 2-feet wide by 2-feet long by 2-feet deep. A high level float type switch (LSH-201) is installed in the sump. In the event that a leak or spill occurs and P-201 cannot pump out the contents of the sump faster than it is being filled, a general alarm condition system trip will be initiated when the liquid level rises above the float.

2.2.10 Instrumentation and Controls

A description of the instrumentation and control components of the system is provided in the following sections. Failsafes have been incorporated into the system design to

prevent undesirable process conditions. Alarm and shutdown conditions are included in the system design to monitor the following key operations of the system:

- Bioreactor temperatures exceeding an adjustable mechanical setpoint (typically set at 190°F).
- High or low pH.
- Loss of liquid level in the bioreactor vessel to a level below the media packing, resulting in aeration air drying out the biofilm.

Each of the above conditions can result in significant die-off of the bacteria population if allowed to continue. If the condition lasts long enough, the entire biomass inventory could be lost, and treatment will cease. Therefore, if any of the above process conditions are sensed by the instrumentation (described below), the system will be shut down. Shutting down the system will limit the stress to the bacteria. Once the alarm condition is isolated and fixed, the failsafes will allow the treatment system to quickly stabilize after restart of the system. This is much more desirable than having to start from scratch, inoculate the bioreactor, and build up sufficient biomass to achieve steady state conditions.

Table 2-1 lists the alarms utilized by the system. Instrumentation functions are discussed below. ~~Strikethrough font~~ indicates that the instrument or function was taken out of service during the August 2002 retrofit of the GCOU.

2.2.10.1 Liquid Level Instrumentation

1. LSHH-101: Normally open (N.O.) float type level switch located in the Lag Fixed-Film Bioreactor (T-101); disables the groundwater extraction pumps (P-301, P-302, and P-303) and initiates a nuisance alarm when the liquid level rises above the elevation of the float.

2. LSLL-104: Normally closed (N.C.) float type level switch located in the Lag Fixed-Film Bioreactor (T-101); initiates a general alarm condition system trip, which results in shutdown of the entire system when the liquid level drops below the elevation of the float.

3. LSH-105: N.O. float type level switch located in the Lead Fixed-Film Bioreactor T-102; initiates a general alarm condition system trip, which results in shutdown of the entire system when the liquid level rises above the elevation of the float.

4. LSL-106: N.C. float type level switch located in the Lead Fixed-Film Bioreactor T-102; initiates a general alarm condition system trip, which results in shutdown of the entire system when the liquid level drops below the elevation of the float.

5. LSH-201: N.O. float type level switch located in the sump; initiates a general alarm condition system trip, which results in shutdown of the entire system when the liquid level rises above the elevation of the float.

2.2.10.2 Pressure Instrumentation

1. PI-102: Pressure gauge located in the influent piping to Lead Fixed-Film Bioreactor T-102; measures the groundwater extraction system forcemain pressure.

4. PI-104: Pressure gauge located in the discharge piping of Aeration Blower B-102; measures the blower's discharge pressure.

5. PS-102: Pressure switch located in the discharge piping of Aeration Blower B-102; the N.O. pressure switch actuates when the discharge pressure rises above an adjustable setpoint. If after a set period of time, the pressure does not rise above the setpoint, the switch initiates a general alarm condition system trip, which results in shutdown of the entire system.

2.2.10.3 Temperature Instrumentation

1. TE-101/TT-101: Temperature sensor and transmitter assembly located in the wall of Lead Fixed-Film Bioreactor T-102. The temperature within the vessel is continuously measured via a resistance temperature detector electrode. A transmitter mounted to the electrode generates a 4 to 20 mA analog output signal. The system programmable logic controller (PLC) receives and interprets the signal. A high temperature alarm is generated when the temperature exceeds a user selectable setpoint; initiating a general alarm condition system trip which results in shutdown of the entire system.

2. TS-102/TI-102: Temperature switch with local indicator located in the discharge piping of Aeration Blower B-102; the N.O. pressure switch actuates when the

discharge temperature rises above an adjustable setpoint (manual adjustment at the temperature indicator dial). If the temperature rises above the setpoint, the switch closes and a high temperature alarm is generated, initiating a general alarm condition system trip, which results in shutdown of the entire system.

2.2.10.4 Miscellaneous Instrumentation

1. FE-101/FIT-101: Magnetic flowmeter with local indicator located in the influent piping to Lead Fixed-Film Bioreactor T-102. The flowrate is continuously measured via a magnetic sensor and a 4 to 20 mA analog output signal is generated. The system PLC continuously receives and interprets the signal.

2. AE-101/AIT-101: pH electrode and transmitter (with local display) located in the effluent piping of Lead Fixed-Film Bioreactor T-102. The system pH is continuously measured via a flat surface electrode and a 4 to 20 mA analog output signal is generated. The system PLC continuously receives and interprets the signal. A low pH alarm is generated when the system pH drops below a user selectable setpoint, initiating a general alarm condition system trip, which results in shutdown of the entire system. Likewise, a high pH alarm is generated when the system pH rises above a user selectable setpoint, initiating a general alarm condition system trip.

2.2.10.5 Control Panel/PLC

A PLC is located in the water-tight main control panel within the treatment building. The control panel is equipped with hand/off/auto selector switches, indicators (pilot lights), and an autodialer. The PLC provides coordination, supervisory control, and interlocking functions for all equipment and individual component controllers.

The indicators communicates status of system alarms and motors The site is equipped with a Supervisory Control and Data Acquisition (SCADA) system, enabling remote observation of the control of the process, and remote operation of key system functions. The SCADA hardware consists of personal computer (PC) located in the control room portion of the treatment building, equipped with a Windows 98 operating system. The PC is networked with the PLC via RS-232 connection, and is configured to perform continuous serial network communication with the PLC. The PC is also equipped with remote-access software, allowing remote users with the correct software and password(s) to access the system with remote PC dialup via modem.

The PC is equipped with the necessary graphic and control software, and the system is programmed and configured to graphically depict all available process parameters, including, but not limited to: motor status, selector switch position, analog inputs (Lead Fixed-Film Bioreactor temperature and pH, as well as system influent flowrate), alarm setpoints, and status of all alarms. Additionally, the system will track and display analog trends vs. time.

The SCADA system has the capability of remote operation of the control system, and is configured to allow the remote operator the following capabilities: motor start and stop, alarm set point configuration, and alarm reset. The SCADA system is equipped with password protection layers in order for operators to operate remote control functions (and prevent unauthorized use of the system).

2.2.10.6 Groundwater Extraction System Control Panels

The groundwater extraction system is equipped with a control panel for EW-301 and EW-302 located in the treatment building and a remote control panel for EW-303 in addition to the treatment system control panel. The motor status from each of the extraction well pumps is tied into the PLC so pump operational status can be monitored remotely. Extraction well pumping cycles are controlled by a current sensing controller (Coyote Controller) in the groundwater extraction system control panels.

2.3 Discharge Line/Outfall

The system effluent discharge line consists of approximately 400 to 650 feet of 3-inch diameter HDPE piping from the treatment building to the discharge point into an on-site grass lined drainage swale which discharges to the on-site wetlands (which drains into Badfish Creek). A corrugated aluminum outfall apron and rock rip-rap was installed at the outfall location.

2.4 Treatment System Building

The treatment system building is a pre-engineered, steel frame building with pre-formed steel siding and standing seam metal deck roof. The building plan has a clear span of 20 feet and a total length of 25 feet with column bay spacing at 12.5 feet on center and an eave height of 12 feet. The structure was insulated. Concrete building foundation includes perimeter spread footings to a depth of 4-feet below grade. The spread footings are 4-feet wide by 1-foot high. The foundation wall is 9-inches wide. The footings and foundation wall include Number 4 rebar on 12-inch centers, each

way. The floor slab is 6-inch thick concrete with 6 by 6 wire mesh reinforcement. The building is equipped with one 10-feet wide by 10-feet high coil-type roll-up door, one 3-feet wide by 7-feet high access door, two electric heaters, interior lights, two receptacles, one exhaust fan, and two vent louvers.

The primary containment, for major releases of treatment water, has been designed into the floor slab. A 6-inch high concrete curb is installed along the perimeter for spill containment. The floor slab includes a concrete lined sump, described previously.

3. Requirements for Routine O&M

This section presents the requirements for the routine operation and maintenance of the groundwater recovery and treatment system.

3.1 General Operation and Maintenance

Since the treatment system utilizes a biological treatment process, operator attention is required to build up the biomass inventory necessary to meet treatment objectives. Once steady state operation is achieved, the groundwater recovery and treatment system will not require an extensive amount of routine operation and maintenance attention. Apart from instrumentation items, the only electrically operated pieces of equipment are the Extraction Pumps (P-301, P-302 & P-303), Aeration Blower (B-102), Nutrient Feed Pump (CMP-105), Carbon Substrate Feed Pump (CMP-104), and the Sump Pump (P-201). **Note that proper Lockout/Tagout procedures should be used to isolate specific electrical equipment requiring maintenance. Refer to Section 8.0 for safety requirements before starting maintenance work.**

The system is automated such that it will not need to be manned on a continual basis. Routine inspection of the system and verification of operating parameters will be done weekly during the first 2 months of operation and then monthly thereafter. The system incorporates provisions for remote monitoring, automatic system shutdown, and remote alarm condition annunciation should adverse operating conditions develop. Alarm conditions are presented in Table 2-1.

During routine inspection of the system, the operator will monitor, and adjust as necessary, the system operating parameters identified in Section 5.0 of this O&M Plan, perform routine maintenance as called for in the maintenance schedule (presented later in this plan), and collect any necessary samples for laboratory analysis. The operator will complete an operating/inspection log each time the system is inspected. A copy of the required operating/inspection log is included as Table 3-1 and will be maintained on-site.

3.2 Equipment Components

This section presents the routine operation and maintenance requirements for the individual equipment components that comprise the groundwater recovery and

treatment system. A summary of the operating requirements for the individual equipment components is presented on Table 3-2. A summary of the maintenance requirements for the individual equipment components is presented on Table 3-3.

3.2.1 Groundwater Extraction Pumps (P-301, P-302 & P-303)

The routine operation and maintenance requirements for the submersible well pumps (P-301, P-303, and P-303) are identified as follows:

Operating Requirements

1. At no time shall the pumps be operated if any of the in-line throttle valves are closed.

2. The pumps shall not be operated if the voltage to the motor is outside of ±10 percent of the motor nameplate voltage.

3. Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. As part of the system startup requirements, the voltage and current draw on each motor lead shall be measured and recorded.

2. On a monthly basis, open well casing to visually inspect condition of the electric drop cable and the pump safety cable and that there are no leaks in the pitless adapter. Check to see that the cables are properly fastened.

3. On a yearly basis, measure the voltage and current draw on each motor lead. Compare to voltage and current draw measured during system start-up.

4. On a yearly basis, pull out pump and inspect the impeller, guide vane, and wear ring for unusual wear. Pump intake and impellers shall be cleaned as necessary. The manufacturer's literature describes the normal wearing of pump components and describes the point at which these parts need to be replaced. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the pump.

5. Pump maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

3.2.2 Lag Fixed-Film Bioreactor (T-101)

The routine operation and maintenance requirements for the Lag Fixed-Film Bioreactor T-101 are identified as follows:

Operating Requirements

1. Pressure in the bioreactor vessel must be limited to atmospheric.

2. The operating pH in the bioreactor (as measured in the bioreactor effluent piping via in-line pH electrode) shall fall in the range of 6.0 and 8.0 to maintain a healthy biomass inventory.

3. The operating dissolved oxygen (D.O.) in the bioreactor (as measured from periodic samples collected from the sample port located in the bioreactor effluent piping) shall be greater than 1.0 milligrams per liter (mg/L) to ensure that the metabolism is not oxygen limited (e.g., metabolism is substrate limited).

4. Bioreactor effluent shall maintain available nutrient concentrations to ensure that the metabolic reactions are not nutrient limited (e.g., metabolism is substrate limited). Nutrient concentrations shall be measured in field samples on a weekly basis via HACH colorimetric test kits. Nutrient analyses shall consist, at a minimum, of ammonium and ortho-phosphate. The concentration of ortho-phosphate in the bioreactor (as measured from periodic samples collected from the sample port located in the bioreactor effluent piping) shall be greater than 0.2 parts per million (ppm). The concentration of ammonia (as N) in the bioreactor (as measured from periodic samples collected from the sample port shall be greater than 1.0 ppm. If the concentrations of either of these nutrients is deficient, increase the nutrient delivery rate by 20 percent.

5. The operating temperature within the bioreactor (as measured in the bioreactor vessel via in-line temperature electrode) shall fall in the range of 50 to 100 °F.

Maintenance Requirements

1. On a monthly basis, the tank will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

2. System monitoring and sampling will be incorporated into the routine maintenance requirements as discussed in Section 5.

3.2.3 Lead Fixed-Film Bioreactor (T-102)

The routine operation and maintenance requirements for the Lead Fixed-Film Bioreactor T-102 are identified as follows:

Operating Requirements

1. Pressure in the bioreactor vessel must be limited to atmospheric.

2. The operating pH in the bioreactor (as measured in the bioreactor effluent piping via in-line pH electrode) shall fall in the range of 6.0 and 8.0 to maintain a healthy biomass inventory.

3. The operating D.O. in the bioreactor (as measured from periodic samples collected from the sample port located in the bioreactor effluent piping) shall be greater than 1.0 mg/L to ensure that the metabolism is not oxygen limited (e.g., metabolism is substrate limited).

4. Bioreactor effluent shall maintain available nutrient concentrations to ensure that the metabolic reactions are not nutrient limited (e.g., metabolism is substrate limited). Nutrient concentrations shall be measured in field samples on a weekly basis via HACH colorimetric test kits. Nutrient analyses shall consist, at a minimum, of ammonium and ortho-phosphate. The concentration of ortho-phosphate in the bioreactor (as measured from periodic samples collected from the sample port located in the bioreactor effluent piping) shall be greater than 0.2 ppm. The concentration of ammonia (as N) in the bioreactor (as measured from periodic samples collected from the sample port shall be greater than 1.0 ppm. If the concentrations of either of these nutrients is deficient, increase the nutrient delivery rate by 20 percent.

5. The operating temperature within the bioreactor (as measured in the bioreactor vessel via in-line temperature electrode) shall fall in the range of 50 to 100 °F.

Maintenance Requirements

1. On a monthly basis, the tank will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

2. System monitoring and sampling will be incorporated into the routine maintenance requirements as discussed in Section 5.

3.2.4 Inclined Plate Clarifier (T-201)

The routine operation and maintenance requirements for the Inclined Plate Clarifier T-201 are identified as follows:

Operating Requirements

1. Pressure in the vessel must be limited to atmospheric.

2. Clarifier operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. On a monthly basis, the vessel will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

2. Clarifier maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

3.2.5 Carbon Substrate Feed System (T-104, CMP-104)

The routine operation and maintenance requirements for the Carbon Substrate Feed Pump CMP-104 and Carbon Substrate Feed Tank T-104 are identified as follows:

Operating Requirements

1. Pressure in the tank must be limited to atmospheric.

Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. On a monthly basis, the tank, feed line, and pump will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

2. The tank will be filled with surrogate carbon substrate on an as-needed basis.

3. Pump maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the pump.

3.2.6 Nutrient Feed System (T-105 & CMP-105)

The routine operation and maintenance requirements for the Nutrient Feed Pump CMP-105 and Nutrient Feed Tank T-105 are identified as follows:

Operating Requirements

1. Pressure in the tank must be limited to atmospheric.

2. Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. On a monthly basis, the tank, feed line, and pump will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

2. On a monthly basis, the tank will be filled with nutrient solution.

3. Pump maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the pump.

3.2.7 Aeration Blower (B-102)

The routine operation and maintenance requirements for the Aeration Blower B-102 are identified as follows:

Operating Requirements

1. At no time shall the blower be operated if the in-line isolation valve (V-113) is closed.

2. The blower shall not be operated if the voltage to the motor is outside of ±10 percent of the motor nameplate voltage.

3. Blower operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. As part of the system startup requirements, the voltage and current draw on each motor lead shall be measured and recorded.

2. On a monthly basis, inspect blower piping for leaks, excessive vibration, and excessive noise.

3. Blower maintenance (including lubrication requirements) shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the blower.

3.2.8 Solids Storage Tank (T-202)

The routine operation and maintenance requirements for the Solids Storage Tank T-202 are identified as follows:

Operating Requirements

1. Pressure in the tank must be limited to atmospheric.

2. Tank operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. On a monthly basis, the tank will be visually inspected for signs of damage, leaks, or excessive deformation of the tank walls.

3.2.9 Sump Pump (P-201)

The routine operation and maintenance requirements for the Sump Pump (P-201) are identified as follows:

Operating Requirements

1. Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Pump maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the pump.

3.2.10 Instrumentation and Electrical Controls

The routine operation and maintenance requirements for the instrumentation and electrical controls incorporated into the system are identified as follows:

Operating Requirements

1. Operation of the instrumentation and electrical controls shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. On a yearly basis, each alarm condition shall be induced to ensure that the electrical components, including the autodialer, are functioning properly.

2. Maintenance of the instrumentation and electrical controls shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the instruments and controls.

3.2.10.1 Liquid Level Instrumentation

Operating Requirements

1. Operation of the liquid level instrumentation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. During system start up, level switches should be cleaned with muriatic acid on a weekly basis. When the bioreactor reaches steady state conditions, level switches should be cleaned on a monthly basis.

2. On a monthly basis, each switch should be tested to ensure accurate alarm response.

3.2.10.2 Pressure Instrumentation

Operating Requirements

1. Operation of the pressure instrumentation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Pressure switches/gauges should be monitored monthly to ensure accurate readings and alarm response.

2. Air pressure gauge should be checked in the field monthly with a hand held magnehelic.

3. Water pressure gauges should be checked monthly by varying flow in pipe through adjusting upstream or downstream valves.

3.2.10.3 Temperature Instrumentation

Operating Requirements

1. Operation of the temperature instrumentation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Calibration of temperature sensor should be checked monthly with a hand held thermometer.

3.2.10.4 Magnetic Flowmeter

Operating Requirements

1. Operation of the magnetic flowmeter instrumentation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Magnetic flow meter should be disassembled and cleaned annually. Troubleshoot sensor in accordance with manufacturer's recommendations.

3.2.10.5 PH Electrode and Transmitter

Operating Requirements

1. Operation of the pH electrode and transmitter shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Calibration of the pH electrode and transmitter should be checked monthly with a hand held pH probe.

2. The in-line probe should be disassembled and cleaned annually.

3.2.10.6 Control Panel/Programmable Logic Controller

Operating Requirements

1. Operation of the control panel/PLC shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Inspect the control panel monthly for burnt out bulbs or other unusual conditions. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on the panel.

3.2.11 Valves

The routine operation and maintenance requirements for the valves are identified as follows:

Operating Requirements

1. Valve positioning shall be thoroughly checked following system maintenance or shut down activities to ensure that the well pump is not operating against a closed valve and to ensure the recovered groundwater is being processed through the necessary treatment processes.

2. Pressure in the valves must be limited to 80 pounds per square inch (psi).

3. Valve operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Maintenance Requirements

1. Valve maintenance shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

3.2.12 Piping

The routine operation and maintenance requirements for piping are identified as follows:

Operating Requirements

1. Pressure in the piping must be limited to 80 psi.

Maintenance Requirements

1. On a monthly basis, all above-grade piping shall be visually inspected for leaks, excessive deflection, excessive vibration, etc. Repair pipe sections and fittings as necessary.

4. System Startup

This section describes pre-startup check-outs, initial system startup, routine system startup, and startup following a general alarm condition system trip.

4.1 Pre-Startup Check-outs

Prior to performing the initial system startup, pre-startup checkouts should be performed as follows:

4.1.1 Mechanical Check

Perform a mechanical check as follows:

1. Check that the installation of all valves, equipment, instrumentation, etc., is complete and in accordance with the project drawings. Any discrepancies that are found are to be corrected before proceeding.

2. Check that all equipment such as check valves and strainers that have flow arrows or other markings to indicate the proper direction of flow have been installed with the proper orientation.

3. Operate every manually operated valve through its entire stroke to make sure that there is no binding, sticking, or other interference.

4. Refer to the manufacturer's literature for all equipment. Ensure that all manufacturer's instructions with regard to installation, cleaning, alignment, and start-up are carefully followed.

5. Check all the following equipment components:

   a) Check all anchors, mounting bolts and clamps to verify tightness.

   b) Check vertical and horizontal alignment.

   c) Check that proper lubricants are being used in all equipment where it is required (e.g. aeration blower).

4.1.2 Construction Debris Removal

Prior to operation, the entire piping system and vessels must be visually inspected for debris and foreign materials. Remove the debris as necessary.

4.1.3 Instrumentation Check

1. Check that all instrumentation equipment, sensing lines, wiring, etc., is complete and according to the project drawings and/or the instrumentation manufacturer's instruction.

2. Check the calibration of all process measurement and transmitting devices, where possible. Refer to the manufacturer's literature for calibration instructions.

3. Check the operation of the various analogs and interlock circuitry loops using a multi-meter.

4.1.4 Control Panel Check

The following procedure should be followed at each panel:

1. Check the voltages before turning on power.

2. Bump all motors to check for proper rotation.

Prior to shipment to the site, all control panels will be shop tested using signal generators and other instruments. PLC outputs, indicators, alarms, program logic, interface terminals and other operating parameters will be checked. The electrical panels and controls will be retested after the equipment is installed.

4.1.5 Fill and Hydraulic Check

The purpose of the hydraulic checkout is to rid the system of any leaks prior to operation. The hydraulic checkout will begin by filling the entire system.

1. Confirm all control panels, vessels, and system components are assembled as dictated by Drawing Numbers PID-1, PID-2, PID-3, and M-2.

2. Close all drain and sample valves.

3. Fill the system with water by enabling the groundwater extraction pumps.

4. Carefully observe all connections, flanges, and screwed fittings. Check and correct all leaks detected.

NOTE: DO NOT DRAIN SYSTEM. THE WATER WILL BE USED FOR THE MECHANICAL SHAKEDOWN.

4.1.6 Mechanical Shakedown

1. Close all system valves.

2. Install the pH electrode and check calibration and operation. Refer to the manufacturer's literature for electrode storage, installation, and operational requirements.

3. Confirm all selector switches on all the control panels are in the OFF position.

4. Switch the power main disconnect switches on all the control panels to the ON position.

5. Check all alarms for the proper response. Refer to Table 2-1 of this manual for a description of alarms.

6. Open V-102, V-103, V-104, V-105, V-106, FCV-109, V-113, V-115, V-117, V-118, V-121, V-123, V-126, V-127, V-128, V-201, V-202, and V-203.

7. Throttle flow control valve FCV-109 until the system flowrate stabilizes to the desired flowrate.

8. Set the Aeration Blower B-102 selector switch to the Hand position. Confirm that the blower and coarse bubble diffusers in Lead Fixed-Film Bioreactor T-102 and Lag Fixed-Film Bioreactor T-101 are operating.

9. Confirm Nutrient Feed Tank T-105 is filled with water to a minimum level of one foot above the foot valve of the Nutrient Feed Pump CMP-105.

10. Set the Nutrient Feed Pump CMP-105 selector switch to the HAND position. Confirm pump is operating properly. Initially it is expected that the nutrient

metering rate will fall in the range of 2.0 to 4.0 milliliters per minute (mL/min). Calibrate the pump for a flowrate of 10 mL/min by adjusting the stroke length and stroke frequency dials at the pump driver. Refer to the manufacturer's literature.

11. Fill the sump with enough water to enable Sump Pump P-201. Confirm that the pump is operating properly.

12. Turn all selector switches to the OFF position.

4.1.7 Integrated System Shakedown

Prior to commencing with startup, a final pre-start checkout must be made in order to check the operation of the systems in an integrated manner, simulating the operation of the system in nearly actual operating conditions. This will enable the operators to become more familiar with the operation of the systems and also ensure that the equipment and controls are working properly as a whole before seeding the system.

The following procedures should be followed:

1. Turn all the selector switches on the control panel to OFF.

2. Turn on power to the control panel. Turn on all circuit breakers and disconnect switches.

3. Actuate the float of LSHH-101 (remove the float assembly from the tank if necessary). Confirm that an alarm condition registered. Acknowledge the alarm.

4. Actuate the float of LSLL-104 (remove the float assembly from the tank if necessary). Confirm that the interlock is functioning properly.

5. Actuate the float of LSH-105 (remove the float assembly from the tank if necessary). Confirm that an alarm condition registered. Acknowledge the alarm.

6. Actuate the float of LSL-106 (remove the float assembly from the tank if necessary). Confirm that an alarm condition registered. Acknowledge the alarm.

7. Close valve V-118 and remove the pH electrode. Place electrode in pH 4.0 buffer solution. Confirm that a low pH alarm is registered (the low pH alarm setpoint default setting is 6.0). Acknowledge the alarm and rinse the electrode.

8. Place electrode in pH 10.0 buffer solution. Confirm that a high pH alarm is registered (the high pH alarm setpoint default setting is 8.0). Acknowledge the alarm and rinse the electrode. Place electrode back into service.

9. Turn all the selector switches to AUTO. Press the RESET/START button to start the system in automatic mode.

10. It should take less than 30 seconds for a low pressure alarm to initiate a general alarm condition system trip and the system should shut down. If the system remains operational, shut the system down and check the pressure switch PS-101 for proper operation. Make the necessary changes and repeat steps 12 through 14. If the system trip occurs, open valve V-122 and proceed to the next step.

11. With all the selector switches turned to AUTO, press the RESET/START button.

12. Confirm that the low flow alarm set-point is 0.5 gpm. Change the set-point at the Operator Interface if necessary.

13. Slowly throttle FCV-109 until the system flowrate drops below the set-point (user adjustable via the SCADA computer). A low flow alarm should be induced within 30 seconds and initiate a general alarm condition system trip. If the system remains operational, shut the system down to troubleshoot. Make the necessary changes and repeat steps 15 through 17. If the system trip occurs, proceed to the next step.

14. If the system is running, shut it down.

15. Check the Aeration Blower B-102 discharge line pressure; if the line is not pressurized, close valve V-128. This will isolate pressure switch PS-102 from the discharge line.

16. With all the selector switches turned to AUTO, press the RESET/START button.

17. It should take less than 30 seconds for a low pressure alarm to initiate a general alarm condition system trip and the system should shut down. If the system remains operational, shut the system down and check the pressure switch PS-102 for proper operation. Make the necessary changes and repeat steps 12 through 14. If the system trip occurs, open valve V-128 and proceed to the next step.

18. Restart the system in automatic mode.

19. Actuate the float of LSH-201 located in the sump crock. A high level alarm should initiate a general alarm condition system trip and the system should shut down.

4.2 Initial System Startup

For any biological process such as the submerged Fixed-Film Bioreactor, the health and efficiency of the biological growth that performs the waste contaminant conversion can only be maintained if this biomass receives an uninterrupted supply of carbon substrate and nutrients. Consequently, after the system is started and the biomass is established in the bioreactor, the system should be kept running continuously whether or not there is any waste water feed. The system should only be shut down if maintenance must be performed that cannot safely be done while the system is operating.

4.2.1 Inoculation

Perform the initial seeding of the bioreactor as follows:

NOTE: Prior to inoculation, it is assumed that the process vessels are filled with water.

1. Slowly throttle flow control valve FCV-109 until the system flowrate stabilizes at 3 gpm.

2. Set the nutrient metering rates to 10 mL/min. At the Operator Interface, set the cycle time for each pump to 16 minutes; set the duration time for each pump to 2 minutes. These settings will yield an average flowrate of approximately 2.0 mL/min.

3. Pour the recommended dosage of seed into the top of the Lead Fixed-Film Bioreactor T-102 and Lag Fixed-Film Bioreactor T-101 vessels. ARCADIS recommends a dosage sufficient to yield a concentration of 400 mg/L.

4. Allow the system to run overnight with zero groundwater feed. This will allow the microorganisms to attach to the media packing.

5. Monitor system operating data and bioreactor effluent for nutrient concentrations. Make adjustments to nutrient and carbon substrate feed rates as necessary.

4.2.2 Initial Groundwater Feed

1. Confirm that V-201 and V-203 are open to allow flow through the clarifier and into the discharge line.

2. Slowly throttle flow control valve FCV-109 until the system flowrate stabilizes at 3 gpm.

3. Turn the selector switches to extraction pumps P-301, P-302, and P-303 to "ON" or "AUTO".

4. Set the nutrient metering rate to 10 mL/min. At the Operator Interface, set the cycle time to 8 minutes; set the duration time to 2 minutes.

5. Operate the system at 3 gpm for a period of 2 days (48 hours).

6. After the system has operated for 48 hours at 3 gpm, incrementally ramp the flow to the desired rate.

During this time, microbial growth will be monitored via feed and effluent groundwater quality testing and field nutrient and D.O. tests. Monitoring and sampling requirements are detailed in Section 5 and the Field Sampling Plan for the Groundwater Control Operable Unit.

4.3 Routine System Shut Down/Startup

One of three types of shutdowns may be performed; a system shutdown, a process shutdown, or an emergency shutdown. A system shutdown is one in which the entire system is shutdown. A process shutdown is one in which the waste water feed flow is stopped, but system equipment continues to operate and the bioreactor is operated in a recycle mode. An emergency shutdown is conducted if a catastrophic fault is detected which requires immediate attention.

CAUTION: Do not perform a system shutdown of the bioreactor unless maintenance is required that cannot safely be performed while the bioreactor is

operating. System shutdowns of the bioreactor may impair the health and efficiency of the biological growth in the bioreactor.

4.3.1 Process Shutdown

In a process shutdown, although the wastewater feed to the system is discontinued, biological activity in the bioreactor will continue for some time. Therefore, the Carbon Substrate Feed system, Nutrient Feed system, Aeration Blower, and Influent Pump should remain functional. Perform a process shutdown as follows:

1. Turn the selector switches for the Extraction Pumps (P-301, P-302 & P-303) to OFF.

4.3.2 System Shutdown

Perform a system shutdown as follows:

1. Turn all pump and mixer selector switches to the OFF position. Refer to the operations and maintenance manuals for the adjacent systems.

2. Switch the main power disconnect to the control panel to the OFF position.

4.3.3 Emergency Shutdown

In the event that a catastrophic fault is detected, it should be determined immediately as to the need of conducting an emergency shutdown of the entire system. The following situations may be deemed as requiring emergency reaction and shutdown:

1. Major Leaks: Leaks due to any of the following failures: cracked/split piping or fittings, failed gaskets or seals, leaking vessels due to clogs, inoperative valves, or vessel rupture. A major leak may also be that which cannot be easily rectified by a simple tightening of the piping/tubing bolting or threading assemblies. Appropriate isolation valves should also be closed to prevent further loss of fluids.

2. Caution: The processing system transports contaminated and/or hazardous fluids. All due safety measures must be employed to prevent operator contact with any contaminated/hazardous fluids.

3. Hazardous Electrical Malfunction: Any electrical device or wiring failure that results in a hazardous condition. This may include broken or sparking wires, electrical overloading caused by power source surging, motor or device failure resulting in overheating/fire within components.

CAUTION: - Extreme caution must be exercised when addressing any electrical malfunction to prevent severe injury of operator. Follow necessary lockout/tagout procedures (Section 8 – Safety Requirements) before working on any electrical equipment.

4. Facility Emergency: In case of fire within the facility or severe inclement weather that threatens the integrity of the facility (flooding/extreme winds/severe electrical storms/abnormal snow loading of roof/earthquake), it may be necessary to also evacuate the premises. If allowable, the system should be shutdown prior to evacuation.

4.3.3.1 Emergency Shutdown Procedures

To immediately cease system operations:

1. Hit emergency stop on the control panel.

2. Locate leaks and close upstream valves.

3. Close the appropriate device's local disconnect switch and/or circuit breaker to isolate. Prior to commencing work on the electrical malfunction, insure that a proper electrical circuit lock-out is made.

4.4 Startup Following a System Trip

If the system has been shutdown by a general alarm condition system trip, the operator must inspect the system and rectify the operating problem. After an automatic alarm condition shutdown, the operator shall check the alarm slate displayed on the Operator Interface. If no alarm condition exists, the operator shall press the RESET/START pushbutton and let the system operate to see if the alarm condition redevelops. The operator shall rectify all operating problems associated with the developed alarm condition.

Once all alarm conditions have been acknowledged, operator shall press the RESET/START pushbutton, which will start the system back up in the automatic mode.

5. Monitoring and Testing Requirements

This section identifies the requirements for the periodic monitoring and testing that will need to be conducted to assess the operating effectiveness of the system.

5.1 Monitoring of System Operating Parameters

The following summarizes the system operating parameters to be monitored, and the frequency that the parameters will be monitored.

5.1.1 Flow Rate

5.1.1.1 Groundwater Extraction Wells

On a weekly basis for the first 2 months of operation and then monthly thereafter, the system operator (i.e., the person, or persons, responsible for the operation of the system) shall record the run time (hour meter) for each extraction pump.

5.1.1.2 Treatment System

The influent flow rate to the Fixed-Film Bioreactor is measured by FE-101/FIT-101. The control package allows this flow rate to be observed from a remote location via the operator interface and SCADA package. Flowrate is measured continuously and recorded at 20 seconds intervals.

5.1.2 Bioreactor Temperature

The temperature in Lead Fixed-Film Bioreactor T-102 is measured by TE-101/TT-101. The control package allows this temperature to be observed from a remote location via the operator interface and SCADA package. The temperature is measured continuously and recorded at 20 second intervals.

5.1.3 System pH

The pH of the Lead Fixed-Film Bioreactor T-102 effluent is continuously monitored by AE-101/AIT-101. The control package allows this parameter to be observed from a remote location via the operator interface and SCADA package. The pH is measured continuously and recorded at 20-second intervals. Calibration of the in-line pH probe will be checked monthly with a handheld pH meter.

5.1.4 Nutrient Concentrations

Performance of the system will be monitored via weekly collection of effluent samples for analysis of the following nutrients: ammonium, nitrate/nitrite, and orthophosphate. These nutrient analyses will be performed using HACH colorimetric field kits in accordance with manufacturers instructions. If the concentration of ammonia is less than 1 ppm, increase the dosage rate by 20 percent. This data will be recorded in a log sheet (along with the name of the operator, date, and time of data collection) kept in the treatment building.

5.1.5 Water Levels

The requirements associated with measuring the water level in the surrounding monitoring wells, and verifying that the recovery system is achieving the necessary groundwater capture, are presented in the Monitoring and Sampling Plan for the Groundwater Control Operable Unit. On a weekly basis for the first 2 months of operation and then monthly thereafter, the system operator shall check and record the water level in Extraction Wells EW-301, EW-302, and EW-303.

5.1.6 Solids Blowdown

The sludge levels will be monitored on a routine basis in the inclined plate clarified and the solids storage tank to determine when the tanks need to be emptied. Sludge will be disposed at the Madison Metropolitan Treatment Plant.

5.1.7 Pressure

The operating pressure of the groundwater extraction forcemain is measured in PI-102 located in the influent piping of Lead Fixed-Film Bioreactor T-102. The operating pressures of Aeration Blower B-101 is measured by PI-104 located in the blower's discharge piping. On at least a monthly basis, the system operator shall check and record the operating pressures from PI-102 through PI-104.

5.1.8 Solids Storage Tank Liquid Level

The liquid level in the Solids Storage Tank T-202 will be monitored and recorded during each visit by the operator. The data will be recorded in a log sheet (along with the name of the operator, date, and time of data collection) kept in the treatment building.

5.1.9 Carbon Substrate Feed Tank Liquid Level

The liquid level in the Carbon Substrate Feed Tank T-104 will be monitored and recorded during each visit by the operator only if supplemental carbon is in use. The data will be recorded in a log sheet kept in the treatment building.

5.1.10 Nutrient Feed Tank Liquid Level

The liquid level in the Nutrient Feed Tank T-105 will be monitored and recorded during each visit by the operator. The data will be recorded in a log sheet kept in the treatment building.

5.2 Groundwater Monitoring

The requirements for periodic groundwater monitoring that will be conducted to assess groundwater quality and the effectiveness of the remedial action are performed in accordance with the long term monitoring program previously approved for the Groundwater Control Operable Unit.

5.3 Treatment Efficiency/Discharge Monitoring

Discharge monitoring, assessing treatment efficiency, and compliance with discharge limits will be in accordance with the Substantive Requirements of Wisconsin Pollutant Discharge Elimination System (WPDES) permit.

6. Potential Operating Problems

During system operation, the potential exists for a component of the recovery and treatment system to malfunction. Usually the cause of the malfunction can be determined quickly and interruption to the system operation can be minimized. A number of design features have been implemented to alert operating personnel if components of the system are nearing their effective capacity and also to alert personnel at the times that a malfunction does occur. Following are descriptions of potential problems that may be encountered during normal operation of the recovery and treatment system along with the operating parameters that will alert personnel that a malfunction has occurred. Section 7.0 describes the necessary action required to alleviate the problem once detected by operating personnel.

6.1 Well Yield Deficiency

For the duration of the groundwater recovery action, the extraction wells may become inefficient and the well yields may be reduced. The reasons for decrease in well efficiency can be caused by incrustation, corrosion, and physical plugging.

Chemical incrustation usually results from the precipitation of carbonates, principally calcium, from groundwater in the proximity of the well screen. The incrustation often forms a hard, brittle, cement-like deposit similar to the scale found in water pipes. The kind and amount of dissolved minerals and gases in natural waters determine their tendency to deposit mineral matter as incrustation.

Corrosion is the natural reversion of metal to its former state. In the environment, elemental metals naturally revert back into more stable compounds. It is a natural process that changes the chemical and physical properties of metals and may over time destroy products. Corrosion can severely limit the useful life of water wells by enlarging the screen slots, reducing the strength of the well material and causing failure, and causing the deposition of corrosion products thereby blocking screen slot openings. The well material used for the extraction wells is stainless steel and thus the potential for a significant amount of corrosion is minimal.

Physical plugging of the well screen is caused by the slow movement of fine formation particles into the area surrounding the screen which may partially plug the well screen or erode the screen openings under certain conditions. The accumulation of the small particles reduces the yield of the well, increases the drawdown or drawup and may damage the screen. Plugging can be caused by improper well design, insufficient well

development, corrosion of the screen or casing, or excessive pump cycling. If the well screen becomes plugged with sediment or mineral deposits, the entrance velocity of the water passing through the remaining openings increases significantly. As a result, fine sediment is entrained that continually erodes the slot openings that allows more sediment to pass into the screen.

In all these scenarios, the problem for the extraction wells would be detected by a noticeable change from anticipated values in the water flow rate, which would be evident either at the in-line flow meters, or if the submersible pumps were to begin malfunctioning. This could cause the flow rate to decrease to a level that may seriously damage the submersible pumps and limit the effectiveness of the groundwater recovery system.

Results of the monthly water level measurements will be used to assess changes in well efficiency over time and will indicate when, if ever, the well needs to be rehabilitated. Prior to startup of the Groundwater Treatment component of the remedy, the extraction wells were rehabilitated to establish a baseline for operation of the GCOU.

6.1.1 Submersible Well Pump Failure

The submersible pumps will be maintained on a scheduled basis, but even through regular maintenance, problems could arise that would indicate the submersible pump is not performing adequately.

If the pump motor is operating properly and the flow rate remains below anticipated values, the problem most likely lies in the actual pump operation. The motor or windings in the pump could be damaged resulting from a low water flow rate, a high amount of sediment being pumped, or a blockage to the pump intake. The power on each pump is regulated by a current sensing controller (Coyote Controller). Low water flow rates caused by extraction well drawdown or a blockage to the pump intake will cause the Coyote Controller to deactivate the pump. In addition, overload current protection is provided for each of the extraction wells which will protect the motors in the event pumping sediments stops the rotation of the pump.

If a submersible pump(s) is/are cycling at a greater than expected frequency, or when the overload is tripped, the pump(s) should be taken off-line for inspection and corrective action measures implemented as necessary.

6.2 Excessive Pressure Build-Up

The treatment system will be pressurized by the force of the water being pumped from the extraction wells through the system. The operating pressure will be recorded during the scheduled operation and maintenance of the system and if the levels increase beyond the normal operating range, corrective action should be conducted.

A potential increase in pressure could occur as a result of an obstruction in the force main and process piping. Obstructions could result from sediment or accumulation of organic material (i.e. bacterial growth) that would either restrict or prevent the flow of water through the system. The increase in pressure under these circumstances would be observed in the system pressure gauges.

6.3 Exceeding Discharge Standards

Although discharge standards are expected to be met given the expected low levels of the constituents of concern in the recovered groundwater and the effectiveness of the fixed film bioreactor, there may be times when the treatment system is unable to meet the applicable standards. Exceeding the applicable discharge standards would be evident based on the periodic analysis of treated effluent samples as described in Section 5.3 of this Operations and Maintenance Plan. In the case that standards are exceeded, regulatory notification will be provided and corrective actions will be implemented in accordance with the substantive requirements of WPDES.

6.4 Leaks

Above ground piping will be visually inspected for leaks and repaired as necessary. The underground lines require periodic comparison of the instrumentation readings to determine if the lines may be leaking.

The force mains from the extraction well to the treatment building, contain a flow meter to provide an indication of flowrate from each extraction well. Periodic comparison of the flowrate to the capacity of the pumps will be made to assess their efficiency. However there are several alternative reasons for low flow which are more likely and should be checked before assuming the force main is leaking. As discussed in other portions of Section 6.0, the well yield may be reduced, the pump or flow meter may require maintenance, or the throttling valve may require adjustment. If no other explanation for low flow can be found, then the system operator should check the flow through the system against the pump curve using a pressure gauge reading at the well

head. If there is a discrepancy that cannot be explained then both the pump and the line should be inspected as possible causes of low flow.

6.5 Treatment System Equipment Failure

The treatment system components (e.g., Influent Pump, Aeration Blower, instrumentation, etc.) will be maintained on a scheduled basis, but even through regular maintenance, problems could arise that would indicate the equipment is not performing adequately. Refer to the equipment manufacturer's literature for diagnostic and corrective action information for the equipment.

6.6 Biological Upsets

Biological systems with low strength influent concentrations are susceptible to process upsets due to the relatively low biomass inventory (when compared to biological systems treating high strength wastewater). The following is a description of identifiable upsets and their likely corrective actions.

If laboratory analyses of influent and effluent samples indicate that little to no reduction in contaminants is occurring, it is likely that a process upset occurred. Likely causes include, but are not limited to:

1. System temperature above 100 °F for significant period of time.
2. pH swings to greater than 8.0 and less than 6.0 for significant period of time.
3. Introduction of a toxic substance or increase in concentrations of substances to toxic levels.
4. Insufficient carbon source to support biomass inventory.
5. Insufficient nutrients to support biomass inventory.
6. Insufficient oxygen to support aerobic metabolism.

Check the on-line instrumentation for proper operation; implement corrective action when necessary.

7. Alternate Operation and Maintenance/Corrective Action

Once operating problems have been observed and a determination made on the problem, a corrective action measure needs to be implemented to correct the problem and allow the system to continue operating at full capacity. Following are the corrective action measures to be initiated based on the potential problems that were presented in Section 6.0.

7.1 Well Yield Deficiency

Experience indicates that if the specific capacity of a well declines by 25 percent, rehabilitation procedures need to be implemented. Based on the specific incident that results in the decreased well yield, there are a number of corrective action measures that can be implemented.

Chemical incrustation - Treating the well with a strong acid solution such as hydrochloric acid, sulfuric acid, or hydroxyacetic acid. The acid is placed in the well and allowed to dissolve the incrusted material. Surge blocks or jetting tools can also be used to expedite the removal of the mineral deposits. The well is then pumped using an air lift pump or similar removal process to remove the water and accumulation of sediments. Typically, the pumps used in the groundwater recovery are not used to remove the extraction well water that has been treated with acid since this most likely would damage the pump.

Physical plugging - If the wells become physically plugged during the operation of the groundwater recovery system, surfactants and dispersing agents can be used to increase the mobility of silt or clay particles which may be clogging the well. By using physical agitation during the procedure, such as jetting, the well yield can be increased dramatically.

7.1.1 Submersible Well Pump Corrective Action

If a submersible pump is performing below its required operating conditions or has stopped functioning, the pump should be removed from the well and a qualified technician should conduct diagnostic procedures to determine the problem. The vendor supplied O&M information should be consulted to aid in troubleshooting and determining any necessary repair procedures for the submersible pump.

7.2 Excessive Pressure Build-Up

If a blockage in the line is the reason for the increased pressure, the location of the blockage would need to be located. Once located, the blockage can be removed by using a jetting device or sewer snake to free the line of obstruction.

7.3 Treatment Measures for Enhanced Removal Efficiencies

If the effluent from the treatment system exceeds discharge limits, an evaluation of the system operation would be made to determine the cause of the problem. Potential treatment system problems will be assessed on a case-by-case basis, with appropriate corrective action initiated after the evaluation is completed. One possible alternative corrective measure is batch operation of the treatment system to maintain the biological activity in the bioreactor while troubleshooting activities and corrective action measures are conducted. Since the groundwater wells can be operated via timers (settings can be adjusted remotely via dial-up access to the SCADA system), the extraction pumps can be shut down for a period of time without shutting down other components of the system (e.g., aeration blower, instrumentation, etc.).

Flexibility is provided with the aeration blower; air flowrates can be modified by adjusting the RPM of the blower shaft. Since the blower is belt driven, the blower RPM is adjusted by installation of a larger/smaller sheave(s) and belt (which are readily available at industrial supply warehouses).

7.4 Leaks

In any case where an underground line is suspected of leaking, the following procedures should be followed (in sequential order):

1. Eliminate all other potential causes of the flow discrepancy prior to conducting Step 2 below.

2. Isolate the line from the extraction pump and the treatment system, pressurize the line (80 psi minimum) with water, and monitor the pressure. If the pressure is stable for one hour, the subgrade piping is not leaking. If a leak is evident, implement Step 3 below.

3. Excavating the line to examine it for leaks. Judgment may be used to identify areas of the pipeline most likely to be leaking (i.e., areas with high vehicle traffic

over a portion of the piping, depressions in the ground surface in areas where the pipe is buried which is indicative of insufficient fill and compaction, wet areas, etc.).

7.5 Treatment System Equipment Failure

The design of the treatment system utilizes off-the-shelf equipment because of greater availability and interchangeability. If any component of the treatment system is performing below its required operating condition or has stopped functioning, the equipment should be examined by a qualified technician to determine the problem. The vendor supplied O&M information will be consulted to aid in troubleshooting and determining any necessary repair procedures. Manufacturer's representatives will be consulted to determine the causes of failures and required corrective action use.

7.6 Biological Upsets

As stated previously, the success of the treatment system is largely dependant upon the health and efficiency of the biological growth that performs the waste contaminant conversion. Unlike a mechanical system, changes to a system operating parameter (e.g., flowrate) do not yield an immediate response in a biological system. There is a time lag in which the bacterial population require to acclimate to the change. This timelag can be significant; from several hours to several days (or even weeks). Therefore, it is extremely important to implement corrective actions in a methodical, step-wise fashion. If monitoring data indicate a process upset has occurred or when the process operating parameters (e.g., pH, temperature, etc.) indicate that a process upset is likely to occur, it is important that the system operator diagnose the system, identify the likely causes of the upset or potential upset, and implement changes to system operation one step at a time. A methodical, scientific approach will allow the system operator to definitively identify both the source of the biological upset and its corrective action.

For example, effluent samples collected for field analysis of nutrient concentrations (e.g., ortho-phosphorous and ammonia) results indicate a limitation of nutrients. The system operator has two corrective actions: 1.) increase the metering rate of nutrients to the system, and 2.) decrease the influent pumping rate of the system. Both of these corrective actions will increase the nutrients in the system effluent.

The bioreactor is the key component of this treatment system. Design features have been incorporated to ensure that this component is appropriately monitored to maintain

a healthy biomass inventory. Extensive monitoring up front is designed to minimize system upsets. If effluent monitoring indicates that the treatment system is not achieving treatment goals, groundwater feed to the system can be interrupted for batch loading to provide additional contaminant reduction.

8. Safety Requirements

8.1 General

When operating the fixed film bioreactor system, safety is to be exercised at all times. For a detailed explanation of safety procedures and guidelines refer to the Site Health and Safety Plan in Appendix F of the Design Report.

8.2 Maintenance Safety

The tracing of circuits with a continuity tester, removal or replacement of components, or revisions to electrical circuits, should be done by a qualified electrician who has been briefed in the requirements of the Health and Safety Plans' procedures for the Site. All power to any electrical terminal inside the control panel with which the worker might come in contact is to be turned off. This usually means every circuit within a control panel or cabinet is to be shut off. In order to properly shut off the power at the control panel, the following rules must be observed:

1. Consult the schematic wiring diagrams (located in a sleeve mounted on the inside of the door to the control panel) to determine what disconnecting switches need to be opened to shut off all of the power at the control panel. Very often it is not sufficient to disconnect the main power source to the control panel. Motor control circuits are usually supplied with power from the motor starters and have to be disconnected by opening the motor circuit switch ahead of the motor starter.

2. Personnel familiar with the plant installation and the location of mechanical devices that physically prevent the transmission or release of energy such as disconnect switches, should be consulted. Shut off all power to the control panel. **The main disconnect switch located outside the treatment building, adjacent to the utility meter, should be locked or tagged in the OFF position until work inside the control panel is completed.**

3. After the switches have been turned OFF, but before work is started in the control panel, make voltage checks on the circuits inside the control panel. This is to confirm that the correct switches have been opened and that circuits have in fact no voltage present.

Sometimes troubleshooting has to be performed while the system is in operation, and power is on the control circuits. This is done by checking for presence or absence of voltage at suitable test points in a control circuit. When checking circuits with the voltage on, the following rules must be observed:

1. Only a person who understands the operation of electrical controls, and who recognizes electrical terminals and other exposed conducting surfaces which might have voltage present, may perform this work.

2. The area of work must be properly illuminated so that all exposed electrical parts can be readily seen.

3. The person performing the work should have the wiring diagrams at hand, and shall use them to locate the points where voltage is to be checked to determine circuit continuity and operation.

4. While work is performed in a control panel with voltage present, another person must be available to give assistance in case of accident. The second person should be familiar with the voltage shut off procedure, and be trained in artificial respiration methods.

5. Make sure that there is adequate clearance around the work, to prevent working in a cramped position. Many people work with one hand in a pocket, to prevent accidental contact of both hands across a voltage source. The Federal Occupational Safety and Health Act part 1910, OCCUPATIONAL SAFETY AND HEALTH STANDARDS specifies a minimum working distance around equipment with live electrical terminals (3-feet up to l volts; 4 feet l51-600 volts). Several types of voltage testers are available. Solenoid type, multimeter, and ruggedized neon lamps are samples. Avoid the use of "homemade rigs with conventional light bulbs which are easily broken (exposing bare wire at 120 volts).

6. One side of the voltage tester should be clipped to a terminal which is part of the electrical neutral side of the line. The test clips should be covered with insulation. This makes it possible for a worker to use only one hand to hold the isolated handle of the potential measuring probe of a voltage tester. The other hand should be kept close to the body (or in a pocket) avoiding contact with either electrical terminals or grounded parts of the structure.

7. The exposed outer end of the potential measuring probe should not exceed 1/8" in length. A short length of snug fitting insulating tubing can be used to cover a portion of the voltage probe so that it can not contact terminals other than the one on which the tip is placed.

8. It is recommended that soft, thin dry leather gloves, or meterman's gloves, safety glasses and rubber soled shoes be used.

9. Rubber floor mats should be provided around the area.

9. Recordkeeping and Reporting Requirements

The following Groundwater Treatment system operation parameters will be monitored and recorded no less frequently than once every day via the SCADA system:

1. Average system flowrate
2. System pH
3. Bioreactor temperature

The above parameters will be reported in a table format and will be included in the Discharge Monitoring Reporting in accordance with the Substantive Requirements of a WPDES permit. During weekly site visits by the System Operator, log sheets will be completed (Table 3-1) and maintained on-site. In addition, maintenance activities will be described on this log sheet.

10. Equipment and Instrumentation List

A bill of materials listing the equipment and instrumentation for the Groundwater Control Operable Unit is included as Appendix A-1. A vendor contact list is provided in Appendix A-2. Note that the Engineer or Contractor has the option to purchase equipment that equals or exceeds the performance of the listed materials. Equipment cut sheets are provided in Appendix A-3.

11. References

ARCADIS. 2003. Final Construction Completion Report, Groundwater Control Operable Unit (GCOU), City Disposal Corporation Landfill, Dunn, Wisconsin.

ARCADIS G&M, Inc. 2000a. Biological Treatment System Startup Action Plan, Groundwater Control Operable Unit, City Disposal Corporation Landfill. Letter from Jon E. Forbort to Dave Hantz, Wisconsin Department of Natural Resources. August 1.

ARCADIS G&M, Inc. 2000b. Discharge Monitoring Report (September 2000) and Request for Extension of the 30-Day Startup Period with the Elevated THF Effluent Limitation. October 25.

ARCADIS G&M, Inc. 1999. Final Design Report, Groundwater Control Operable Unit, City Disposal Corporation Landfill. December 21.

Earth Tech, Inc. 1999. Interim Remedial Action Report, City Disposal Corporation Landfill, Groundwater Control and Operable Unit, Dunn, Wisconsin.

OSHA, Occupational Safety and Health Standards, The Federal Occupation Safety and Health Act part 1910.

TABLES

ARCADIS

Table 2-1. Groundwater Treatment System Alarm Points List, City Disposal Corporation Landfill, Dunn, Wisconsin.

Alarm	Location	Description	Results	Range/Units	Default Value	Adjustable Delay (sec)
LAHH-101	Lag Fixed-Film Bioreactor	High, High Liquid Level	Alarm, System Trip	Fixed Switch Point	Fixed	10
LALL-104	Lag Fixed-Film Bioreactor	Low, Low Liquid Level	Alarm, Enable Recycle Mode	Fixed Switch Point	Fixed	10
LAH-105	Lag Fixed-Film Bioreactor	High,Liquid Level	Alarm, System Trip	Fixed Switch Point	Fixed	10
LAL-106	Lag Fixed-Film Bioreactor	Low, Liquid Level	Alarm, System Trip	Fixed Switch Point	Fixed	10
TAL-101	LeadFixed-Film Bioreactor	Low, Temperture Level	Alarm, Nuisance	0 - 100 °F	50 °F	10
TAH-101	LeadFixed-Film Bioreactor	High, Temperture Level	Alarm, System Trip	0 - 100 °F	100 °F	10
AAL-101	LeadFixed-Film Bioreactor	Low, pH Level	Alarm, System Trip	0 - 14 pH Units	6	10
AAH-101	LeadFixed-Film Bioreactor	High pH Level	Alarm, System Trip	0 - 14 pH Units	9	10
TAH-102	Blower line	High, Temperture Level	Alarm, System Trip	0 - 300 °F	190 °F	10
PAL-102	Blower line	Low, Pessure Level	Alarm, System Trip	0 - 10 psi	3 psi	10
LAH-201	Sump Pit	High, Liquid Level	Alarm, System Trip	Fixed Switch Point	Fixed	10

gpm Gallons per minute.
psi Pounds per square inch.
sec Seconds.

Table 3-1. Groundwater Treatment System Operating/Inspection Log, City Disposal Corporation Landfill, Dunn, Wisconsin.

Operator Initials								
Date								
Time								
Weather Conditions								
Building Temperature (°F)								
Maintenance Activities Performed (Y or N)								
(If yes describe below)								
System Operating on Arrival?								
Extraction Well EW-301 (Y or N)								
Extraction Well EW-302 (Y or N)								
Extraction Well EW-303 (Y or N)								
Influent Pump P-101 (Y or N)								
Blower B-102 (Y or N)								
Pressure Readings:								
PI-102(psi)								
PI-104(psi)								
Sludge Thickness:								
Inclined Plate Clarifier								
Thickener Running (Y or N)								
Solids Storage Tank								
Flow Readings:								
Influent FE/FIT-101 (gpm)								
Influent FE/FIT-101 (Total Gallons)								
Extraction Pumps:								
P-301 Run Time (hours)								
P-302 Run Time (hours)								
P-303 Run Time (hours)								
Tank Level:								
Carbon Substrate Feed Tank								
Nutrient Feed Tank								
Sample Collected								
Influent (Yor N)								
pH								
Temperature (°F)								
DO (mg/L)								
Appearance								
Odor								
Effluent (Y or N)								

Table 3-1. Groundwater Treatment System Operating/Inspection Log, City Disposal Corporation Landfill, Dunn, Wisconsin.

pH								
Temperature (°F)								
Iron (mg/L)								
DO (mg/L)								
Ammonium NH_4-N (mg/L)								
Orthophosphate PO_4-P (mg/L)								
Appearance								
Odor								

Notes/Observations:

Table 3-2. Operating Requirements for Groundwater Treatment System Components, City Disposal Corporation Landfill, Dunn, Wisconsin.

Component	Operating Requirements
Extraction Well Pumps	At no time shall the pump be operated if any of the in-line throttle valves are fully closed.
	The pumps shall not be operated if the voltage to the motor is outside of ±10% of the motor nameplate voltage.
	Pump operation shall be in accordance with the manufacturer's recommendations.
Lag Fixed-Film Bioreactor (Formerly Influent Equalization Tank)	Pressure in the tank must be limited to atmospheric.
	The pH in the bioreactor must fall in the range of 6.0 to 8.0.
	Contents should be well-mixed with a coarse bubble "roll" along one axis of the vessel.
	The DO in the bioreactor must be greater than 1.0 mg/L.
	Temperature in the bioreactor shall fall in the range of 50 to 100 degrees F.
	Bioreactor effluent shall maintain available nutrient concentrations to ensure that the metabolic reactions are not nutrient limited.
	Tank operation shall be in accordance with the manufacturer's recommendations.
Lead Fixed Film Bioreactor	The pH in the bioreactor must fall in the range of 6.0 to 8.0.
	Contents should be well-mixed adequate aeration and multiple coarse bubble "rolls".
	Liquid level within the vessel must be greater than 8 feet.
	The DO in the bioreactor must be greater than 1.0 mg/L.
	Pressure in the bioreactor vessel must be limited to atmospheric.
	Temperature in the bioreactor shall fall in the range of 50 to 100 degrees F.
	Bioreactor effluent shall maintain available nutrient concentrations to ensure that the metabolic reactions are not nutrient limited.
Inclined Plate Clarifier	Clarifier operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.
	Pressure in the clarifier must be limited to atmospheric.
Carbon Substrate Feed System	Pressure in the tank must be limited to atmospheric.
	Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.
Nutrient Feed System	Pressure in the tank must be limited to atmospheric.
	Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.
Aeration Blower	At no time shall the blower be operated if the in-line isolation valve V-113 is closed.
	The blower shall not be operated if the voltage to the motor is outside of ±10% of the motor nameplate voltage.
	Blower operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.

Footnotes on Page 2.

Table 3-2. Operating Requirements for Groundwater Treatment System Components, City Disposal Corporation Landfill, Dunn, Wisconsin.

Component	Operating Requirements
Solids Storage Tank	Tank operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.
	Pressure in the tank must be limited to atmospheric.
Sump Pump	Pump operation shall be in accordance with the manufacturer's recommendations identified in the manufacturer's supplied O&M information.
Instrumentation and Electrical Controls	Operation of the instrumentation and electrical controls shall be in accordance with the manufacturer's recommendations.
Valves	Valve positioning shall be thoroughly checked following system maintenance or shut down activities to ensure that the extraction well pumps are not operating against a closed valve and to ensure the collected groundwater is being processed through the necessary teatment processes.
	Pressure in the valves must be limited to 80 psi.
	Valve operation shall be in accordance with the manufacturer's recommendations.
Piping	Pressure in the piping must be limited to 80 psi (the maximum rating of the piping components).

~~xxx~~ Strikethrough text denotes that equipment was taken out of service during August 2002 retrofit.

Table 3-3. Preventative Maintenance Schedule and Requirements, Groundwater Treatment System, City Disposal Corporation Landfill, Dunn, Wisconsin.

Component	Maintenance Activity	Frequency
Extraction Well Pumps	As part of the system startup requirements, the voltage and current draw on each motor lead shall be measured and recorded.	System Startup
	Open each well casing to visually inspect condition of the electric drop cable and the pump safety cable. Check to see that each cable is fastened properly. Check that there are no leaks in the discharge piping.	Monthly
	Measure the voltage and current draw on each motor lead. Compare to voltage and current draw measured during system start-up.	Yearly
	Pull out pump and inspect the impeller, guide vane, and wear ring for unusual wear. Pump intake and impellers shall be cleaned as necessary. The manufacturer's literature describes the normal wearing of pump components and describes the point at which these parts need replacement. Pump maintenance shall be in accordance with the manufacturer's recommendations.	Yearly *
Lag Fixed-Film Bioreactor (Formerly Influent Equalization Tank)	Ensure level switches are clean and operating properly. Inspect tank for signs of damage, leaks, or excessive deformation of the tank walls. System monitoring and sampling will be incorporated into the routine maintenance requirements as discussed in Section 5 of the Operation and Maintenance Plan for Groundwater Control Operable Unit.	Monthly
Fixed Film Bioreactor	Inspect tank, piping, and pumps for signs of damage, leaks, or excessive deformation of the tank walls. System monitoring and sampling will be incorporated into the routine maintenance requirements as discussed in Section 5 of the Operation and Maintenance Plan for Groundwater Control Operable Unit.	Monthly
Inclined Plate Clarifier	Inspect vessel and piping for signs of damage, leaks, or excessive deformation of the tank walls.	Monthly
	Clarifier maintenance shall be in accordance with the manufacturer's recommendations.	*
Carbon Substrate Feed System	Inspect tank, feed lines, and pumps for signs of damage, leaks, or excessive deformation of the tank walls.	Monthly
	Tank will be filled with surrogate carbon substrate on an as-needed basis.	*
	Pump maintenance shall be in accordance with the manufacturer's recommendations.	*
Nutrient Feed System	Inspect tank feed lines and pumps for signs of damage, leaks, or excessive deformation of the tank walls. Tank will be filled with nutrient solution. Nutrient injection lines should be checked for obstructions and cleaned.	Monthly
	Routine maintenance of elastomeric parts is essential for optimum performance. This involves replacing the Liquifram cartridge valves or seal rings/valve balls, and the injection check spring.	Annually
	Pump maintenance shall be in accordance with the manufacturer's recommendations.	*
Aeration Blower	As part of the system startup requirements, the voltage and current draw on each motor lead shall be measured and recorded.	System Startup
	Inspect blower piping and pumps for leaks, excessive vibration, and excessive noise.	Monthly
	Blower maintenance, including routine lubrication, shall be in accordance with the manufacturer's recommendations.	*
Solids Storage Tank	Inspect tank and piping for signs of damage, leaks, or excessive deformation of the tank walls.	Monthly

Footnotes on Page 2.

Table 3-3. Preventative Maintenance Schedule and Requirements, Groundwater Treatment System, City Disposal Corporation Landfill, Dunn, Wisconsin.

Component	Maintenance Activity	Frequency
Sump Pump	Pump maintenance shall be in accordance with the manufacturer's recommendations.	*
Instrumentation and Electrical Controls	Each alarm condition (e.g., low flow, high pressure, etc.) shall be induced to ensure that the electrical components, including the autodialer, are functioning properly.	Yearly
Liquid Level Instrumentation	During system start up level switches should be cleaned with muriatic acid on a weekly basis.	Monthly
	At steady state conditions, level switches should be cleaned on a monthly basis.	
	Switches should be tested monthly to ensure accurate alarm response.	
Pressure Instrumentation	Pressure switches/gauges should be monitored to ensure accurate readings and alarm response.	Monthly
	Air pressure gauge should be cheched in the field monthly with a hand held magnehelic.	
	Water pressure gauges should be checked by varying flow in pipe by adjusting upstream or downstream valves.	
Temperature Instrumentation	Calibration of temperature sensor should be checked monthly with a handheld thermometer.	Monthly
	Troubleshoot sensor in accordance with the manufacturer's recommendations.	
Magnetic Flowmeter	Magnetic flow meter should be disassembled and cleaned annually. Calibration of the flow meter should be checked monthly by measuring the volume of flow dicharged from the sample port over a designated period of time. Troubleshoot sensor in accordance with manufacturer's recommendations.	Monthly
pH Electrode and Transmitter	Calibration of temperature sensor should be checked monthly with a handheld pH meter.	Monthly
	If necessary, recalibrate sensor using the two point method.	
	Troubleshoot sensor in accordance with the manufacturer's recommendations.	
Control Panel/PLC	Maintenance of the instrumentation and electrical controls shall be in accordance with the manufacturer's recommendations.	Monthly
	Inspect control panel for burnt out bulbs or other unusual conditions.	
Valves	Cycle or open and close valves to ensure proper operations.	Monthly
	Valve maintenance shall be in accordance with the manufacturer's recommendations.	
Piping	All above-grade piping and the piping shall be inspected for leaks, excessive deflection, excessive vibration, etc.	Monthly
	Repair pipe sections and fittings as necessary.	

* As recommended in vendor supplied O&M information.

~~xxx~~ Strikethrough text denotes that equipment was taken out of service during August 2002 retrofit.

APPENDIX A

Appendix A-1

Bill of Materials

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
1	1	**Influent Equalization Tank** Capacity: 3,000 gal. Dimensions: 8 ft dia. x 8.83 ft. high Includes four (4) 2" FNPT bulkhead fittings, and five (5) 1-1/2" FNPT bulkhead fittings Materials: Cross Linked, Low Density Polyethylene, 1.35 S.G. **Tag: T-101**	Influent Line	Poly Processing	Liqui Flo
2	1	**Fixed-Film Bioreactor** Capacity: 4,250 gal. Dimensions: 9.0 ft dia. x 10.0 ft. high Materials: Carbon steel, 1/8" corrosion allowance, interior/exterior coatings Notes: Includes packing supports, influent header supports, nozzles, lifting lugs. **Tag: T-102**	Reactor Vessel	IPS	Arbortech Corporation
3	1	**Influent Pump** Capacity: 25 gpm @ 10 ft. TDH Connections: 1" x 1" FNPT Acceptable Wetted Materials: Cast Iron Motor: 1800 RPM, 1/4 hp, 240 VAC, 1 ph., TEFC Service: Groundwater **Tag: P-101**	Influent Line	Ingersoll-Dresser Model 1-1/4 x1x4 SMP	Furey Filter and Pump
4	1	**Aeration Blower** Capacity: 50 scfm @ 6 psi Connections: 2" x 2" FNPT Materials: Carbon Steel Motor: 3600 RPM, 3 hp, 240 VAC, 1 ph., TEFC Accessories: V-Belt Drive, Inlet Air Filter, Inlet and Outlet Silencers, Belt Guard, Steel Frame Mount, Industrial Blue Paint, Adjustable Temperature Switch w/ Gauge Service: Air **Tag: B-102**	Aeration Line	Kaeser Compressors, Inc.	CPR Services, Inc.

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
5	2	**Feed Tanks with Cover** Capacity: 55 gallon drums Material: Steel Service: Water containing nitrogen and phosphorous compounds, alcohol **Tag: T-104 & T-105**	Carbon Substrate Feed, Nutrient Feed	NA	NA
6	2	**Metering Pumps** Flow: 0.001 to 0.42 gph Connections: 0.375" OD compression Max. Injection Pressure: 110 psi Output Per Stroke: 0.13 to 0.44 mL Stroke Frequency: 0.6 to 60 spm 120 VAC, 22 Watts, 1 ph., 60 Hz Material: Polypropylene head/fittings, ceramic balls, polyprel seals *Includes 1/4" OD, UV resistant polyethylene tubing (16'), 4 function valve,* injection checkvalve, suction filter, splash shields for A series LMI metering pumps Service: Water containing nitrogen and phosphorous compounds, alcohol **Tag: CMP-103 & CMP-104**	Carbon Substrate Feed, Nutrient Feed	LMI P131-391SI	Furey Filter and Pump
7	1	**Inclined Plate Clarifier** Design: 25 gpm, 100 mg/L TSS (biosolids, metal precipitates) Efficiency: Effluent quality of <10 mg/L TSS Materials: Carbon Steel Dimensions: Service: Water containing biosolids and metal precipitates. **Tag: T-201**	Effluent	Model HFIPC-220	Arbortech Corporation

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
8	1	**Solids Storage Tank** Capacity: 3,000 gal. Dimensions: 6'-1" dia. x 14' long, 3" Saddles Materials: 3/16" Th. Carbon Steel, Exterior Prime Coat Penetrations: Two (2) 16" Manways, Three (2) 2" Half Couplings Pressure Rating: Atmospheric Service: Biological sludge **Tag: T-202**	Solids Line	IPS	Arbortech Corporation
9	3	**Ball Valve** Connection: 2" soc, True Union Material: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Temperature Rating: 120 °F max. Service: Groundwater **Tag: V-101, V-102 & V-106**	Influent Tank	Hayward	Modular Piping
10	4	**Ball Valve** Connection: 1-1/2" soc, True Union Material: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Temperature Rating: 120 °F max. Service: Groundwater **Tag: V-103, V-104, V-105 & V-117**	Instrument Isolation	Hayward	Modular Piping
11	1	**3-Way Ball Valve w/ Electric Actuator** preassembled Connections: 2" FNPT, True Union Wetted Materials: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Normal Operating Temperature: 50 to 100 °F Service: Groundwater containing biosolids Actuator Specifications: Electric **Tag: FV-107**	Instrument Isolation	Hayward	Modular Piping

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
12	1	**Swing Check Valve** Connection: 2" Flanged Wetted Materials: PVC Body, EPDM Elastomers Pressure Rating: Temperature Rating: Service: Groundwater containing biosolids **Tag: V-108**	Influent Pump Discharge	Asahi	Modular Piping
13	1	**Globe Valve** Connection: 2" soc Wetted Materials: PVC Body, Polypropylene Disc, EPDM Elastomer Pressure Rating: 150 psi Temperature Rating: 140 °F Service: Groundwater containing biosolids **Tag: FCV-109**	Bioreactor Influent	Asahi Catalog No. 47535K46	McMaster Carr
14	2	**Spring Check Valve** Connection: 1/4" FNPT Material: 316 SS Body, 302 SS Spring Cracking Pressure: 25 psi Pressure Rating: 3000 psi Temperature Rating: 300 °F **Tag: V-110 & V-111**	Carbon Substrate Feed, Nutrient Feed	Swagelok SS-4CP4-25	Badger Valve & Fitting Corp.
15	3	**Ball Valve** Connection: 2" soc, True Union Material: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Temperature Rating: 120 °F max. Service: Groundwater **Tag: V-112, V-115, & V-118**	Bioreactor Vessel	Hayward	Modular Piping

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
16	3	**Ball Valve** Connection: 1-1/2" Th. FNPT Material: Bronze Pressure Rating: Temperature Rating: Service: Air **Tag: V-113A, B, &C**	Aeration	Jamesbury	Simone Engineering
17	4	**Spring Check Valve** Connection: 1-1/2" Th. FNPT Material: Bronze Body, 316 SS Spring Cracking Pressure: 0.5 psi Pressure Rating: 400 psi Temperature Rating: 325 °F Service: Air **Tag: V-114A, B, &C, V-120**	Aeration	Conbraco Catalog No. 47715K29	McMaster Carr
18	1	**Ball Valve w/ Electric Actuator** preassembled Connection: 2" FNPT, True Union Wetted Materials: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Normal Operating Temperature: 50 to 100 °F Service: Groundwater containing biosolids Actuator Specifications: Electric **Tag: FV-119**	Recycle, Effluent	Hayward	Modular Piping
19	1	**Ball Valve** Connection: 2" soc, True Union Material: PVC Body, EPDM Elastomers Pressure Rating: 150 psi Temperature Rating: 120 °F max. Service: Groundwater **Tag: V-201**	Clarifier Influent	Hayward	Modular Piping

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
20	2	**Butterfly Valve** Connection: 3" Lug Wafer for ANSI Class 150 Flange Material: PVC Body, PP Disc, EPDM Elastomer Pressure Rating: 150 psi @ 70 °F Temperature Rating: 140 °F Service: Groundwater containing biosolids **Tag: V-202 & V-203**	Clarifier Effluent, Solids	Hayward	Modular Piping
21	1	**Ball Valve** Connection: 2" Th. FNPT Material: Bronze Pressure Rating: Temperature Rating: Service: Sludge **Tag: V-204**	Solids Tank	Jamesbury	Simone Engineering
22	4	**Level Switch** Type: Reed Switch, Horizontal Mounting Process Connection: 1/2" MNPT Conduit Connection: 1/2" MNPT Material: Polypropylene Switch Rating: SPST, 34 Watts Max. Pressure Rating: 100 psig Max. Temperature Rating: 221 °F Max. To be used with flexible and rigid conduit Service: Groundwater **Tag: LSH-102, LSL-103, LSLL-104 & LSL-106**	Influent Tank, Bioreactor	Madison M8700 Catalog No. 46515K41	McMaster Carr
23	2	**Level Switch** Type: Reed Switch, Vertical Mounting Process Connection: 1/4" MNPT Material: 316 SS Switch Rating: SPST, 60 Watts Max. Pressure Rating: 200 psig Max. Temperature Rating: 392 °F Max. To be used with flexible and rigid conduit Service: Groundwater **Tag: LSHH-101 & LSH-105**	Influent Tank, Bioreactor	Madison M5600 Catalog No. 4646K85	McMaster Carr

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
24	8	**Ball Valves** Connection: 1/4" Th. FNPT Material: Bronze Pressure Rating: Temperature Rating: Service: Air/Water **Tag:**	Instrument Isolation	Jamesbury	Simone Engineering
25	1	**RTD Temperature Sensor w/ Transmitter** Temperature Range: 0 to 150 °F Process Connection: 1/2" MNPT Conduit Connection: 1/2" FNPT Material: Aluminum Housing, 316 SS Element Housing: NEMA 4 Power Supply: 18 to 90 VDC Accuracy: 0.1% Ouput: Isolated 4 to 20 mA Immersion Length: 4" Normal Operating Temperature: 0 to 100 °C Service: Grounwater containing biosolids **Tag: TE-101, TT-101**	Influent Line	Pyromation	Simone Engineering
26	1	**Thermowell** Type: Straight Shank Instrument Connection: 1/2" FNPT Process Connection: 3/4" MNPT Material: 316 SS Insertion Length: 2 1/2" Lag Extension: 0 Pressure Rating: 7,000 psi at 200 °F Bore Size: 0.260" Standard Normal Operating Pressure: 6.5 ft. head Normal Operating Temperature: 32 to 100 °F Service: Groundwater containing biosolids **To be used with TE-101**	Influent Line		Simone Engineering

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
27	3	**Pressure Gauge** Range: 0 to 15 psi Connection: 1/4" MNPT Bottom Connection Wetted Materials: Copper Alloy Size: 2 1/2" Face Accuracy: +/- 2% Scale **Tag: PI-101, PI-102, & PI-104**	Influent Line, Aeration Line	Ashcroft	Simone Engineering
28	1	**Pressure Gauge** Range: 0 to 30" Hg. / 0 to 15 psi Connection: 1/4" MNPT Bottom Connection Wetted Materials: Copper Alloy, Brass Size: 2 1/2" Face Accuracy: +/- 2% Scale **Tag: PI-103**	Aeration Blower Inlet Piping	Ashcroft	Simone Engineering
29	1	**Pressure Switch** Range: 0.4 to 18 psi Deadband: Fixed 0.12 to 0.26 psi Process Connection: 1/4" FNPT Conduit Connection: 7/8" Knockout Holes Wetted Materials: SS Diaphragm: SS Enclosure: NEMA 4 Maximum Pressure: 60 psi Electrical Rating: 10 Amps @ 125/250 VAC Accuracy: +/- 0.5% **Tag: PS-101**	Influent Line	Barksdale DIH-H18SS Catalog No. 5004K13	McMaster Carr

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
30	1	**Pressure Switch** Range: 3 to 30 psi Deadband: Fixed 0.4 to1.25 psi Process Connection: 1/4" MNPT Conduit Connection: 7/8" Knockout Holes Wetted Materials: Aluminum Diaphragm: Buna N Enclosure: NEMA 1 Maximum Ambient Temperature: 160 °F Maximum Pressure: 230 psi Electrical Rating: 15 Amps @ 125/250 VAC Accuracy: +/- 1% **Tag: PS-102**	Aeration Line	United Electric H54-24 9509 Catalog No. 4779K12	McMaster Carr
31	1	**Temperature Switch** Temperature Range: 140 to 300 °F Process Connection: Conduit Connection: Material: Housing: Power Supply: Accuracy: Immersion Length: Normal Operating Temperature: 0 to 100 °C Service: Air/Water **Tag: TI-102, TS-102**	Aeration Line	DA-7035-153-7N	Dwyer Instruments
32	1	**Magnetic Flowmeter w/ Local Indication** Range: 2.7 to 60 gpm Connection: 1" ANSI Class 150 Flange or Wafer Acceptable Wetted Materials: 316 SS, Viton, PTFE Accuracy: +/-5% Power Requirements: 120 VAC, 60 Hz., 15 Watts Enclosure: NEMA 4 Output: 4 to 20 mA Service: Groundwater containing biosolids **Tag: FE-101, FT-101**	Influent Line	Bailey Fisher & Porter Model 10D1475W	Simone Engineering

Bill of Materials, Fixed-Film Bioreactor, City Disposal Corporation Landfill, Dunn, Wisconsin.

ITEM	QTY	DESCRIPTION	SYSTEM LOCATION	MODEL NO.	VENDOR
33	1	**pH Transmitter** Range: 0 to 14 pH Units, Adjustabe Span Material: Glass-filled polypropylene, silicone rubber keypads Power: 10 to 30 VDC Temperature Compensation: Automatic, 50 to 185 °F Accuracy: +/-0.2% percent of scale Output: Isolated 4 to 20 mA Enclosure: NEMA 4X/IP65 Display: Black LCD **TAG: AIT-101**	Effluent Line	Signet Model: Transmitter: 3-8710	Simone Engineering
34	1	**pH Analyzer** Type: Disposable, Submersion Installation, Flat Electrode, 2" Saddle Mounting Hardware, Sensor Cap Preamplifier assembly (15' shielded six conductor cable) pH Range: 0 to 14 pH Units Process Connection: Custom Conduit Connection: 3/4" MNPT Material: CPVC body, Viton O-rings, Polyethylene reference junctions Reference: Ag/AgCl Reference gel: 3.5M KCl Temperature Rating: 50 to 185 °F Pressure Rating: 100 psig Max. Service: Groundwater containing biosolids **Tag: AE-101**	Effluent Line	Signet Model: Electrode: 3-2714 Preamp: 3-2720 2"x3/4" Saddle: PV8S020 Threaded Cap: P31542	Simone Engineering

Appendix A-2

Groundwater Treatment System
Vendor Contact List

Attachment A-2. Groundwater Treatment System Vendor Contacts List, City Disposal Corporation Landfill, Dunn, Wisconsin.

	Address	Phone	Fax	Contact
Arbortech	3607 Chapel Hill Road, McHenry, IL 60050	(815) 385-0001	(815) 385-0088	Ron Graffia
Badger Valve & Fitting Corp.	1504 Underwood Avenue, Wauwatosa, WI 53213	(262) 790-6100	(262) 790-5262	Jack Shreve
CPR Services, Inc.	17915 W. Lincoln Street, New Berlin, WI 53151	(414) 782-6581	(414) 782-6582	Thomas H. Meier
Diffused Gas Technologies, Inc.	1776 Mentor Avenue, Suite 360, Cincinnati, OH 45212	(513) 531-4426	(513) 531-4436	Steve Deiters
Dwyer Instruments, Inc.	102 Highway 212, P.O. Box 373, Michigan City, IN 46361	(219) 879-8000	(219) 872-9057	No contact
Energenecs	W59 N249 Cardinal Avenue, Cedarburg, WI 53012-0153	(414) 377-6360	(414) 377-1515	Rob W. Lecey, P.E.
Farm Better	132 W. Ottawa Avenue, Dousman, WI 53188	(262) 965-3357	(262) 965-4307	Chris Hettich
Food Ingredients	2100 Airport Road, Waukesha, WI 53188	(262) 521-8118	(262) 521-2085	Bill Wright
Furey Filter & Pump, Inc.	12300 W. Carman Avenue., Milwaukee, WI 53225	(414) 358-5555	(414) 358-5544	Jack Furey
Liqui-Flo Incorporated	9730 N. Granville Road, Mequon, WI 53097	(414) 242-3825	(414) 242-8974	Robert Kloehn
McMaster-Carr	600 County Line Road, Elmhurst, IL 60126-2081	(630) 833-0300	(630) 834-9427	No contact
Modular Piping Supply	5160 North 125th Street, Bulter, WI 53007	(414) 781-2055	(414) 781-1168	Bob Roach
Simone Engineering, Inc.	12121 Corporate Parkway, Mequon, WI 53092-3332	(414) 243-3600	(414) 243-3611	Gregory L. Durecki

Appendix A-3

Equipment Cut Sheets

Cat. No. 49-434B

OWNER'S MANUAL

Please read before using this equipment.

Security Auto Dialer

Radio Shack®

IMPORTANT SAFETY INSTRUCTIONS

When using your telephone equipment, basic safety precautions should always be followed to reduce the risk of fire, electric shock and injury to persons, including the following:

1) Read and understand all instructions.
2) Follow all warnings and instructions marked on the product.
3) Unplug this product from the wall outlet before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.
4) Do not use this product near water, for example, near a bath tub, wash bowl, kitchen sink, or laundry tub, in a wet basement, or near a swimming pool.
5) Do not place this product on an unstable cart, stand, or table. The product may fall, causing serious damage to the product.
6) Slots and openings in the cabinet and the back or bottom are provided for ventilation, to protect it from overheating these openings must not be blocked or covered The openings should never be blocked by placing the product on the bed, sofa, rug or other similar surface. This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation unless proper ventilation is provided.
7) This product should be operated only from the type of power source indicated on the appliance. If you are not sure of the type of power supply to your home, consult your dealer or local power company.
8) Do not allow anything to rest on the power cord. Do not locate this product where the cord will be abused by persons walking on it.
9) Do not overload wall outlets and extension cords as this can result in the risk of fire or electric shock.
10) Never push objects of any kind into this product through cabinet slots as they may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock. Never spill liquid of any kind on the product.
11) To reduce the risk of electric shock, do not disassemble this product, but take it to a qualified service facility when some service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect reassembly can cause electric shock when the appliance is subsequently used.
12) Unplug this product from the wall outlet and refer servicing to qualified service personnel under the following conditions:
    A) When the power supply cord or plug is damaged or frayed.
    B) If liquid has been spilled into the product.
    C) If the product has been exposed to rain or water.
    D) If the product does not operate normally by following the operating instructions. Adjust only those controls, that are covered by the operating instructions because improper adjustment of other controls may result in damage and will often require extensive work by a qualified technician to restore the product to normal operation.
    E) If the product has been dropped or the cabinet has been damaged.
    F) If the product exhibits a distinct change in performance.
13) Avoid using the product during an electrical storm. There may be a remote risk of electric shock from lightning.
14) Do not use the telephone to report a gas leak in the vicinity of the leak.

SAVE THESE INSTRUCTIONS

Installation Instructions

1. Never install telephone wiring during a lightning storm.
2. Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations.
3. Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface.
4. Use caution when installing or modifying telephone lines.

811290010D

FEATURES

Your Radio Shack Security Auto Dialer is an excellent addition to your security system. When your alarm system is violated, the dialer automatically dials up to three stored numbers (each up to 16 digits long) and plays your recorded message.

This solid state dialer is intended for use with Radio Shack Cat. No. 49-485, Cat. No. 49-451, or similar home security systems.

The dialer has these special features.

Digital Outgoing Message — ensures the clearest possible recording of the message you record. The dialer's digital chip saves the outgoing message you record.

Easy Installation — lets you quickly connect the dialer to your phone line, alarm system, and AC power.

Versatile Alarm System Inputs — let you connect the dialer to many different types of alarm systems.

Switchable Speaker — lets you turn the dialer's speaker on so you can hear the dialer work. Or, you can turn the speaker off so it cannot be heard by an intruder.

Three Memory Numbers — let you save up to 3 phone numbers, to make it more likely that your message will make it through to someone who can take action.

No Battery Backup Required — you can connect the dialer to your alarm system's auxiliary battery power, so it will work even if main AC power is lost.

Mounting Options — you can place the dialer on a desk, shelf, or table, or mount it on a wall.

This dialer has been tested and found to comply with all applicable UL and FCC standards.

We recommend you record your dialer's serial number here. The number is on the bottom of the dialer.

Serial Number: _____

Warning: To prevent fire or shock hazard, do not expose this product to rain or moisture.

This dialer is UL classified under Standard Number 1459 for fire and risk of electric shock.

READ THIS FIRST

We have designed your dialer to conform to federal regulations, and you can connect it to most phone lines.

Most devices, such as a phone or answering machine, that you connect to the phone line draw power from the line. We refer to this power draw as the device's ringer equivalence number, or REN. This dialer has a REN of 0, so it places no load on the phone line.

FCC STATEMENT

Your dialer complies with Part 68 of *FCC Rules*. You must, upon request, provide the Federal Communications Commission (FCC) registration number and the REN to your telephone company. Both numbers are shown on the bottom of the dialer.

Note: You must not connect your dialer to:

- Coin-operated systems
- Party-line systems
- Most electronic key phone systems

In the unlikely event that your dialer causes problems on the phone line, the phone company can temporarily disconnect your service. If this happens, the phone company attempts to notify you in advance. If advance notice is not practical, the phone company notifies you as soon as possible and advises you of your right to file a complaint with the FCC.

Also, the phone company can make changes to its lines, equipment, operations, or procedures that could affect the operation of this dialer. The phone company notifies you of these changes in advance, so you can take the necessary steps to prevent interruption of your telephone service.

CONTENTS

INSTALLATION

SELECTING A LOCATION

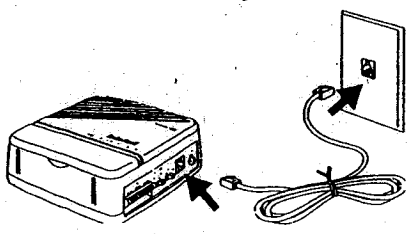
Select a location for the dialer that is:

- Near an AC outlet
- Near a modular phone line jack
- Near the alarm system
- Out of an intruder's sight and hearing

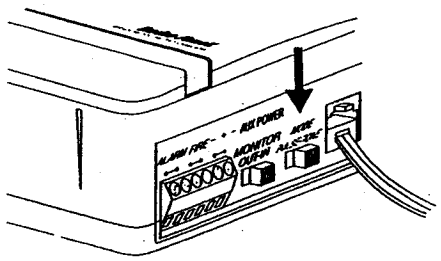
If the selected phone line jack is not a modular jack, you must update the wiring. You can convert the wiring yourself, using jacks and adapters available at your local Radio Shack store. Or, you can let the phone company update the wiring for you. The USOC number of the jack to be installed is RJ11C (or RJ11W for a wall jack).

CONNECTING TO THE PHONE LINE

1. Insert the supplied phone cord's modular plug into a modular phone jack. Then plug the other end into the dialer's jack.



2. Set **MODE** on the side of the dialer for the type of service you have (tone or pulse).



CONNECTING THE DIALER TO YOUR ALARM SYSTEM

You can connect the dialer to either of the following types of alarm system output terminals:

- Siren or alarm
- Contact closure

Notes:

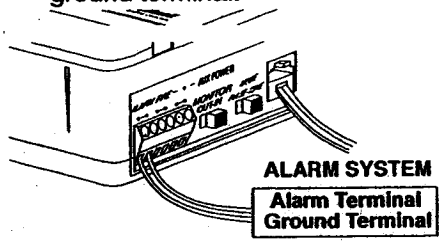
- If your alarm system has auxiliary power outputs, you should also connect your dialer to them if you want the dialer to operate during an AC power failure. See "Connecting to Auxiliary Power" on Page 8.
- If you connect the dialer to a siren or alarm output but do not connect it to your alarm system's auxiliary battery power (see "Connecting to Auxiliary Power" on Page 8), it only receives power from the alarm system's siren or alarm output while the alarm is sounding. In this case, if AC power is disconnected, the dialer only operates while the alarm is sounding.

- Use the wire size recommended by your alarm system's manufacturer to make the connections. Otherwise, you can use hookup wire such as Cat. No. 278-863 to make the connections.

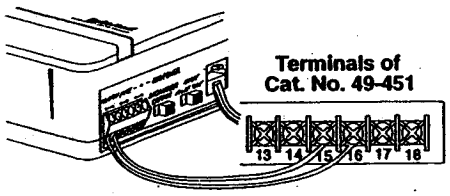
Connecting to Siren or Alarm Outputs

Follow these steps to connect the dialer to any alarm system that provides a siren or alarm output to trigger and power the dialer.

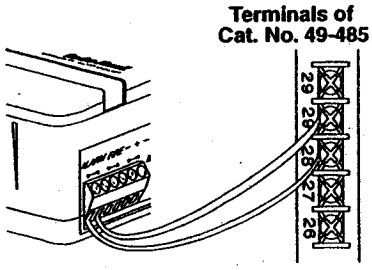
1. Connect one of the **ALARM** terminals on the side of the dialer to your alarm system's alarm terminal.
2. Connect the dialer's other **ALARM** terminal to your alarm system's ground terminal.



If you have a Cat. No. 49-451 alarm system, connect the dialer's **ALARM** terminals to Terminals 15 and 16 on that system.

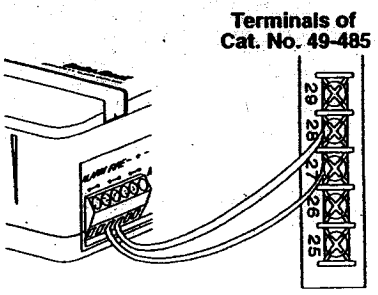


If you have a Cat. No. 49-485 alarm system, connect the dialer's **ALARM** terminals to Terminals 28 and 29 on that system.



3. Connect one of the **FIRE** terminals on the dialer to your alarm system's fire terminal.
4. Connect the dialer's other **FIRE** terminal to your alarm system's ground terminal.

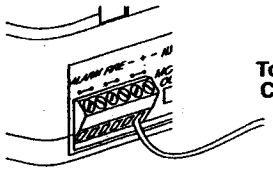
   If you have a Cat. No. 49-485 alarm system, connect the dialer's **FIRE** terminals to terminals 27 and 28 on the alarm system.



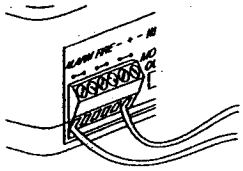
Connecting to Contact Closure N.O. (Normally Open) Terminals

Follow these steps to connect the dialer to any terminals on your alarm system that provide a contact closure when the alarm is triggered.

1. Connect the **AUX POWER +** terminal on the side of the dialer to one of your alarm system's contact closure terminals.

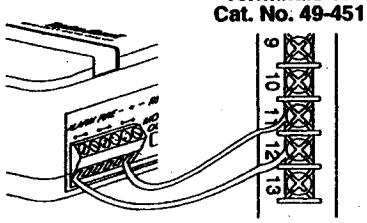


2. Connect one of the **ALARM** terminals on the dialer to your alarm system's other contact closure terminal.



If you have a Cat. No. 49-451 alarm system, connect the dialer's **AUX POWER +** terminal to Terminal 11, then connect one of the dialer's **ALARM** terminals to Terminal 12.

Contact Closure Terminals of Cat. No. 49-451

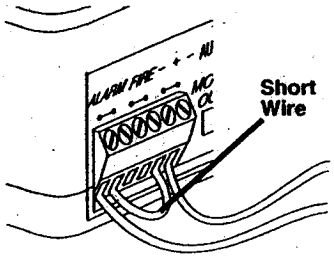


If you have a Cat. No. 49-485 alarm system:

For burglar alarm activation, connect the dialer's **AUX POWER +** terminal to Terminal 32, then connect one of the dialer's **ALARM** terminals to Terminal 33.

For fire alarm activation, connect the dialer's **AUX POWER +** terminal to Terminal 30, then connect one of the dialer's **ALARM** terminals to Terminal 31.

3. Use a short piece of wire to connect the **AUX POWER –** terminal on the dialer to the remaining **ALARM** terminal on the dialer.



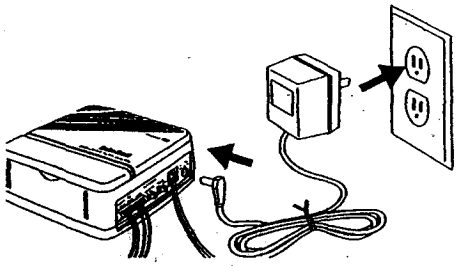
CONNECTING POWER

Connecting to AC Power

During normal operation, the dialer is powered by the supplied AC adapter.

Cautions:

- The supplied Class 2 AC adapter supplies 12 volts of power, delivers at least 200 milliamps, and has a plug that properly fits the dialer's **DC 12V** jack. Using an adapter that does not meet these specifications could damage the dialer.
- Always plug the adapter into the dialer before you plug it into an AC outlet, and unplug the adapter from the outlet before you unplug it from the dialer.



1. Insert the supplied adapter's barrel plug into the dialer's **DC 12V** jack.
2. Plug the adapter's other end into a standard AC outlet. The POWER indicator on the dialer lights.

Connecting To Auxiliary Power

If AC power fails and you connected the dialer to your alarm system's auxiliary battery power, the alarm system's battery powers the dialer instead.

Although your dialer is normally powered by an AC adapter, if your alarm system has auxiliary battery power terminals, you should connect your dialer to them in case AC power is lost during an emergency.

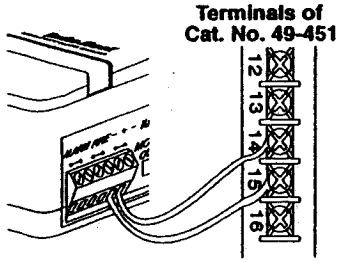
Caution: Your alarm system's auxiliary battery must supply 12 volts and deliver at least 200 milliamps. Using an auxiliary battery that does not meet these specifications could damage the dialer, the battery, or the alarm system. Refer to your alarm system's owner's manual for more information about its auxiliary battery power system.

Refer to the owner's manual provided with your alarm system to determine the correct connections, then follow these steps to connect the dialer to your alarm system's auxiliary battery power.

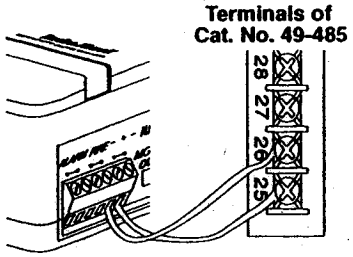
1. Connect the **AUX POWER +** terminal on the side of the dialer to your alarm system's positive (+) auxiliary battery terminal.

2. Connect the **AUX POWER** – terminal on the side of the dialer to your alarm system's negative (–) auxiliary battery terminal.

   If you have a Cat. No. 49-451 alarm system, connect the dialer's **AUX POWER** + terminal to Terminal 14, then connect the **AUX POWER** – terminal to Terminal 15.

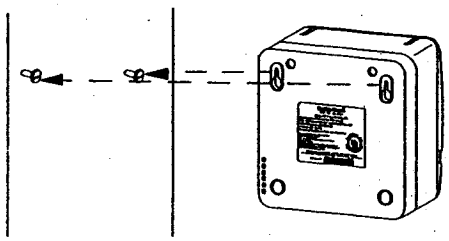


   If you have a Cat. No. 49-485 alarm system, connect the dialer's **AUX POWER** + terminal to Terminal 25, then connect the **AUX POWER** – terminal to Terminal 26.



MOUNTING THE DIALER ON A WALL

To mount the dialer directly on a wall, you need two wood screws (not supplied) with heads that fit into the keyhole slots on the bottom of the dialer.



1. Using the holes on the back of the dialer as a guide, mark the mounting screw locations $3\frac{1}{8}$ inches apart on the wall.
2. Drill a hole in the wall at each marked location.
3. Thread a screw into each hole until the screw's head extends about $\frac{1}{8}$ inch from the wall.
4. Align the keyhole slots on the back of the dialer with the screw heads in the wall, then slide the dialer down onto the screws until it is secure.

SET-UP

HOW THE DIALER WORKS

When you connect the dialer to an alarm system and the alarm system is violated, the dialer automatically dials the phone numbers you stored in memory and plays the message you recorded.

When the dialer is activated, it hangs up any active call on your phone line, then pauses 15 seconds to disconnect any answering machine on your phone line. Then the dialer dials the first number you stored in it and waits 6 rings for the call to be answered.

If someone answers, the dialer sounds five single tones (if the alarm is a fire alarm) or five high-low sounds (if the alarm is a burglar alarm), then plays your outgoing message if you recorded one. If no one answers, the dialer then calls the next stored number and repeats this sequence.

Notes:

- If you set the dialer to dial each stored number only one time (see "Selecting the Number of Dial Attempts" on Page 12), it stops after dialing the third number, even if no one answered. If you set the dialer to dial each stored number three times, it repeats the above sequence for all unanswered numbers until either someone answers or all three numbers have been dialed three times.
- If the dialer dials a number and detects a busy signal, it redials that number only if you set the dialer to dial each stored number three times.
- If your alarm system indicates that there is a fire alarm and a burglar alarm at the same time, the dialer sounds only the signal for a fire alarm.

STORING PHONE NUMBERS INTO MEMORY

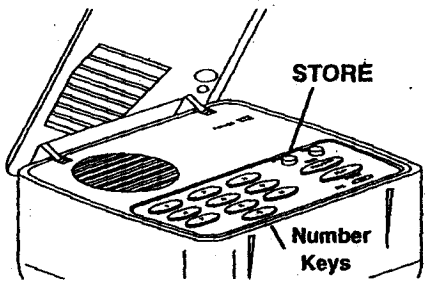
You can store up to three numbers to be dialed in the event of an alarm.

Important:

- We recommend you program the dialer to call a friend who can determine if there is a real problem. The person can then call the police, if necessary, or call you back to see if everything is fine. You should *not* program the dialer to dial the police directly, unless your local police have a special line for automatic telephone dialers.

- If you want to program the dialer to call your local police and fire department, check with them first. Some police and fire departments do not accept calls from automatic telephone dialers. If your police or fire department does not accept calls from automatic dialing equipment, you can program it to call a friend or private security service who can notify the police or fire department, if necessary.
- If you want to program the dialer to call a private security service, note that some private security services charge a fee to accept calls from automatic dialing equipment. For more information, call the private security services in your area.

Follow these steps to store a number.

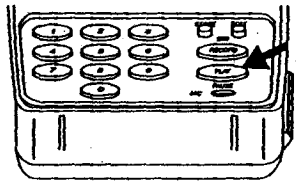


1. Lift the cover on the dialer, then press **STORE**.
2. Press **1**, **2**, or **3** to select the memory location for the number, and the order in which the number will be called.
3. Enter the phone number (up to 16 digits).

   If you make a mistake while entering the number, press **STORE** then begin again from Step 2.
4. Press **STORE**. The dialer sounds a 1-second beep.
5. Repeat Steps 1–4 to enter more numbers.

Notes:

- If you try to store more than 16 digits, the dialer beeps 4 times and does not store the number.
- If you use the dialer on a phone system that requires you to dial an access code for an outside line, you should program a pause after the access code to allow time for the outside line to connect. To program a 2-second pause between digits, press **PLAY/PAUSE** at the point in the dialing sequence where you need to pause.



Pressing **PLAY/PAUSE** counts as one of the 16 digits available in a memory location.

To replace a number, simply store a new one in its place.

To clear a number from memory, do only Steps 1, 2, and 4.

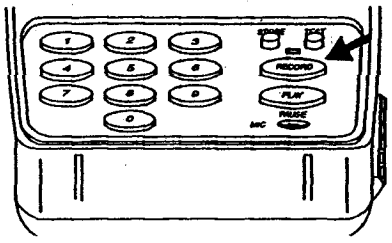
RECORDING AN OUTGOING MESSAGE

Your outgoing message can be up to 20 seconds long. Here is a typical outgoing message:

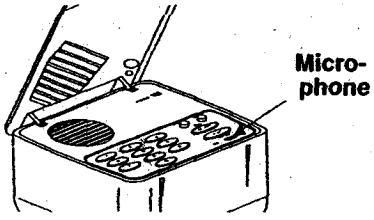
"This is the John Doe Residence at 812 Maple Street. If you heard five single tones at the start of this message, our alarm is indicating a fire. Notify the fire department. If you heard five high-low tones at the start of this message, our alarm is indicating a burglary. Notify the police department."

Follow these steps to record the message.

1. Press **RECORD**. The RECORD indicator lights.



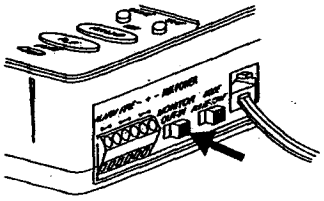
2. Speak clearly in a normal volume about 12 inches away from the microphone on the front of the dialer.



The RECORD indicator turns off after 20 seconds.

3. If you finish your message before the RECORD indicator turns off, press **RECORD** to stop recording.

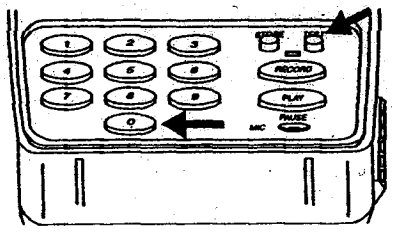
You can hear the outgoing message by setting **MONITOR** to **IN**, then pressing **PLAY/PAUSE**. To stop playback before the message ends, press **PLAY/PAUSE** again.



SELECTING THE NUMBER OF DIAL ATTEMPTS

The dialer is preset to call each stored number once. However, you can set the dialer so it calls each number up to three times until a call to that number has been answered.

To change the currently set number of dial attempts, pull up on the dialer's cover, press **TEST**, then press **0**.



The dialer sounds a tone when you have set it to call three times. The dialer sounds no tone when you set it to call one time only.

TESTING THE DIALER

You can test the dialer to make sure it correctly dials the numbers and plays the outgoing message.

Notes:

- Before you test the dialer, call each of the numbers that the dialer will dial and notify them about the test.
- Test the dialer only during off-peak hours, such as early morning or late evening.

To test the dialer, press **TEST** then the number for the memory location you want to test (**1**, **2**, or **3**).

Notes:

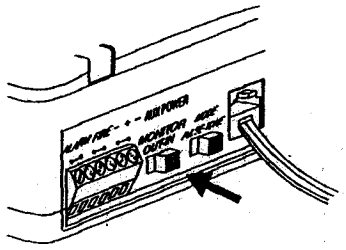
- If you want to hear the outgoing message and any response, you can set the dialer so it monitors the test (see "Listening to the Outgoing Message").
- If you select a memory location that does not have a phone number stored in it, the dialer sounds three short beeps.

The dialer dials the number. If the call is answered, the dialer plays the outgoing message you selected. If there is no answer, the dialer hangs up after 6 rings and tries the next number in sequence. After it finishes with the last number, the dialer exits the test mode and sounds three short beeps. The dialer plays the entire message, even if the call is ended by the person or device.

LISTENING TO THE OUTGOING MESSAGE

You can set the dialer so you can hear it dial a number and play the outgoing message, and hear any response to the call. This is handy if you want to monitor the dialer when you test it. Or, if you are using a burglar alarm system with a silent alarm, you might want to set the dialer so that it cannot be heard.

To set the dialer so you can hear the outgoing message and any response, set **MONITOR** on the side of the dialer to **IN**. Set **MONITOR** to **OUT** to mute the dialer.



CARE AND MAINTENANCE

Your Radio Shack Security Auto Dialer is an example of superior design and craftsmanship. The following suggestions will help you care for your dialer so you can use it for years.

Keep the dialer dry. If it gets wet, wipe it dry immediately. Liquids might contain minerals that can corrode the electronic circuits.

Use and store the dialer only in normal temperature environments. Temperature extremes can shorten the life of electronic devices and distort or melt plastic parts.

Keep the dialer away from dust and dirt, which can cause premature wear of parts.

Handle the dialer gently and carefully. Dropping it can damage circuit boards and cases and can cause the dialer to work improperly.

Wipe the dialer with a damp cloth occasionally to keep it looking new. Do not use harsh chemicals, cleaning solvents, or strong detergents to clean the dialer.

Modifying or tampering with the dialer's internal components can cause a malfunction and might invalidate the dialer's warranty and void your FCC authorization to operate it. If your dialer is not performing as it should, take it to your local Radio Shack store for assistance. If the trouble is affecting the telephone lines, the phone company can ask you to disconnect the dialer until you have resolved the problem.

LIGHTNING

Your dialer has built-in protection circuits to reduce the risk of damage from surges in phone and power line current. These protection circuits meet or exceed FCC requirements. However, lightning striking the phone line or power lines can damage your dialer.

Lightning damage is not common. Nevertheless, if you live in an area that has frequent electrical storms, we suggest that you unplug your dialer during storms to reduce the possibility of damage.

SPECIFICATIONS

DTMF Dialing

Minimum level of single tone (loop current 20 mA, typical)
- Low group ..... –5.5 dBm
- High group ..... –3.5 dBm

Maximum level of frequency pair (loop current 40 mA) ..... 1.0 dBm

Pause Time ..... 2.0 seconds

Pulse Dialing

Dialing Rate ..... 10 pps

Breaking Ratio 60%

Inter-Digital Pause ..... 800 ms

Audio Performance

S/N Ratio (Record/Play, ref. 1 kHz) ..... Greater than or equal to –30 dB

RX Level (ref 1 kHz loop current at 40 mA) ..... 50 mW

TX Level (Record/Play, 1 kHz loop current at 40 mA)
- Freq. = 500 Hz ..... –15 dBm
- Freq. = 1 kHz ..... –13 dBm
- Freq. = 2.5 kHz ..... –20 dBm

Frequency Response (Record/Play, ref. to 1 kHz, outgoing message to line)
- 500 Hz ..... 0 dB
- 2500 Hz ..... –6 dB

Off-Hook Line Input Impedance (at 50 mA Loop Current)
- Freq. 200-3500 Hz ..... 650 ± 30 Ω

DC Line Impedance (Off Hook DC resistance, at 20 mA) ..... Less than 301 Ω

Distortion (Record/Play, ref 1 kHz) ..... Less than 6% (typical)

Output to Speaker (Playback) ..... 90 dB SPL

Beep Tone Output ..... 95 dB SPL

Beep Tone Frequency ..... 850 Hz

Operation Parameters

Number of rings before call terminated 6

Number of call attempts per stored message
- 1 × Call mode 1
- 3 × Call mode 3

DTMF Tone Signal

Fire ..... DTMF Key #3 Tone

Burglar ..... Alternating DTMF Key #0 and Key #2 Tones

Operating Voltage Range

Burglar Alarm Input ..... 10–18 V DC

Fire Alarm Input ..... 10–18 V DC

Auxiliary Power Input ..... 10–18 V DC

Wall Adapter Input ..... 12 V DC @ 200 mA

Auxiliary Power Output ..... 11–19 V DC

Record Time ..... 20 seconds

Ringback Tone Detection Sensitivity (Minimum Line Level) ..... –30 dBm

Power Consumption

Steady State 12 V DC AUX Input ..... Less than 50 mA

Active 12 V DC AUX Input (Message Playback) ..... Less than 75 mA

Steady State AC Power Consumption
12 V DC Adapter Input ..... Less than 5 Watts

Dimensions (HWD) ..... $1\frac{3}{4} \times 4\frac{5}{8} \times 4\frac{1}{4}$ Inches
(45.5 × 115 × 108 mm)

Weight ..... 12 oz
(340 g)

Specifications are typical; individual units might vary. Specifications are subject to change and improvement without notice.

Limited Ninety-Day Warranty

This product is warranted by Radio Shack against manufacturing defects in material and workmanship under normal use for ninety (90) days from the date of purchase from Radio Shack company-owned stores and authorized Radio Shack franchisees and dealers. EXCEPT AS PROVIDED HEREIN, RADIO SHACK MAKES NO EXPRESS WARRANTIES AND ANY IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE DURATION OF THE WRITTEN LIMITED WARRANTIES CONTAINED HEREIN. EXCEPT AS PROVIDED HEREIN, Radio Shack SHALL HAVE NO LIABILITY OR RESPONSIBILITY TO CUSTOMER OR ANY OTHER PERSON OR ENTITY WITH RESPECT TO ANY LIABILITY, LOSS OR DAMAGE CAUSED DIRECTLY OR INDIRECTLY BY USE OR PERFORMANCE OF THE PRODUCT OR ARISING OUT OF ANY BREACH OF THIS WARRANTY, INCLUDING, BUT NOT LIMITED TO, ANY DAMAGES RESULTING FROM INCONVENIENCE, LOSS OF TIME, DATA, PROPERTY, REVENUE, OR PROFIT OR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, EVEN IF Radio Shack HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Some states do not allow the limitations on how long an implied warranty lasts or the exclusion of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

In the event of a product defect during the warranty period, take the product and the Radio Shack sales receipt as proof of purchase date to any Radio Shack store. Radio Shack will, at its option, unless otherwise provided by law: (a) correct the defect by product repair without charge for parts and labor; (b) replace the product with one of the same or similar design; or (c) refund the purchase price. All replaced parts and products, and products on which a refund is made, become the property of Radio Shack. New or reconditioned parts and products may be used in the performance of warranty service. Repaired or replaced parts and products are warranted for the remainder of the original warranty period. You will be charged for repair or replacement of the product made after the expiration of the warranty period.

This warranty does not cover: (a) damage or failure caused by or attributable to acts of God, abuse, accident, misuse, improper or abnormal usage, failure to follow instructions, improper installation or maintenance, alteration, lightning or other incidence of excess voltage or current; (b) any repairs other than those provided by a Radio Shack Authorized Service Facility; (c) consumables such as fuses or batteries; (d) cosmetic damage; (e) transportation, shipping or insurance costs; or (f) costs of product removal, installation, set-up service adjustment or reinstallation.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Radio Shack Customer Relations, Dept. W, 100 Throckmorton St., Suite 600, Fort Worth, TX 76102

We Service What We Sell 3/97

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A Division of Tandy Corporation
Fort Worth, Texas 76102

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HYDRO-FLO TECHNOLOGIES, INC.

INCLINED PLATE CLARIFIER

INSTALLATION OPERATION & MAINTENANCE INSTRUCTIONS

MODEL HFIPC

TABLE OF CONTENTS

PREFACE

The information found in this manual is based on years of experience with the installation, operation and maintenance of this type of equipment, however it is intended only as a guide. The methods that are available to you may require other, more appropriate procedures for the proper installation of this equipment. Proper care and safety should always be paramount. Use only qualified technicians and procedures in compliance with local building codes.

WARRANTY

Hydro-Flo Technologies warranties its equipment to be free from defects in materials or workmanship for a period of one year from startup or 16 months from shipment, whichever occurs first. Any component manufacturer's warranty will supersede this warranty and shall take precedence.

HYDRO-FLO TECHNOLOGIES will not accept any back charges for warranty work, changing, adjusting, servicing or any other work that has not received advanced written authorization. HYDRO-FLO TECHNOLOGIES will grant authorization for the changing, adjusting or servicing of this equipment only in the interest of warranty repair, or to correct any deficiency discovered. Such work will only be considered upon written agreement from Hydro-Flo Technologies to do so.

INSPECTION

Thoroughly inspect all equipment upon arrival. If any items are missing or damaged, note this on the shipping papers and contact your transportation company representative and HYDRO-FLO TECHNOLOGIES immediately.

Touch up all coatings damaged during shipment immediately. See the specification information for this particular piece of equipment for proper procedures for coatings touchups.

STORAGE

If you are not ready to install the equipment upon arrival, store it in an area away from traffic. The ground should be level and free of any sharp objects that might damage the structure or coatings. Store the equipment with all factory packing intact as much as possible until ready for installation. Store the equipment out of the elements, preferably indoors. If this is not possible, make sure the equipment does not fill with water and debris. We recommend you cover the equipment with a tarp. Store any pumps and other accessory items in a similar fashion.

ADDITIONAL INFORMATION

For additional information that may be required for this installation or for answers to any questions you might have, contact Hydro-Flo Technologies.

INSTALLATION

Study the general arrangement drawing and make yourself familiar with all aspects of the installation, operation and maintenance of this equipment.

TOOLS REQUIRED FOR INSTALLATION

1. Masonry drill with masonry bit set for the installation of the equipment anchors (if applicable).
2. Standard socket set, wrench set and miscellaneous drift pins for the installation and adjustment of the effluent weir and removable lid sections (if applicable).
3. Carpenter's level for leveling width of clarifier.
4. Clear 3/8" or 1/2" tubing for leveling length of clarifier and weir plates.
5. Caulking gun for the caulking of the adjustable oil weir.

LIFTING THE CLARIFIER

Warning: Clarifier must be empty (no water) when lifted!

All clarifiers are designed to be lifted vertically and moved into place. Always lift the clarifier with the removable lid(s) bolted in place.

Attach lifting cables directly to all lifting eyes on the unit. Check load balance and readjust if required.

ANCHORING AND LEVELING OF EQUIPMENT

For the clarifier to operate correctly the unit must be level. Steps for anchoring and leveling of the equipment are as follows:

1. Make sure that the ground is free of any sharp objects that might damage the coating.
2. Set the tank in position on a level floor or pad. If the floor or pad is not level, use a good quality machinery grout to level the unit after drilling and installing the anchor bolts. Follow the grout manufacturer's instructions for shimming and grouting when leveling the clarifier.

3. Mark the anchor bolt locations.

4. Move the equipment aside and drill holes for the anchors of your choice. Install the anchor bolts per the manufacturer's recommendations. We recommend using, as a minimum, 3/4" diameter x 4" to 6" long embedment type anchor bolts. HYDRO-FLO TECHNOLOGIES does not supply the anchor bolts.

   Note: If grouting is required, the height the anchor bolts extends above the surface must be increased to compensate for the thickness of the grout layer.

5. Set the clarifier back in place.

6. Level the clarifier from side to side by placing a good quality level on top of the fixed effluent weir wall.

7. Level the clarifier from influent end to effluent end by using the clear tubing filled with water. Level the clarifier so that the water in the clear tubing on both ends is at the top of the flange radius. Check level at several points on each end.

8. Securely tighten anchor bolt nuts.

INSTALLATION OF INCLINED PLATE MEDIA PACKS

1. Remove clarifier lid(s) if supplied.

2. Insure packs are at the correct angle for installation into the clarification chamber.

3. Lower inclined plate pack media into place between pack positioning plates.

4. Insure that the packs are secure, level and resting on the guide rails at the bottom on the clarification chamber.

5. Repair any damaged coating.

6. Re-install clarifier lid(s) after installing/adjusting both weirs and water testing the installation.

PLUMBING

When making plumbing connections to the clarifier, the plumbing must be properly supported to carry the weight of the plumbing when full of water. Damage caused to this equipment by improperly supported plumbing will void the warranty.

Connections do not have to be made in the order listed below. Review your situation and make the plumbing connections in the most logical order for your installation.

When making connections to the clarifier tank, do not use the clarifier as a pipe support. All plumbing connections should be properly supported so as not to add stress to the clarifier fittings.

HYDRO-FLO TECHNOLOGIES cannot honor a warranty for tank failure due to improperly supported piping or incorrect installation.

CONNECT THE EFFLUENT PLUMBING

The effluent plumbing must be the same size or larger than the nozzle size on the equipment. Do not reduce the size of the effluent piping as this might cause hydraulic overloading of the equipment. Also, try to run the discharge piping as short a distance as possible, through as few changes of direction as possible and at a pitch of not less than 1/16" per foot.

CONNECT THE INFLUENT PLUMBING

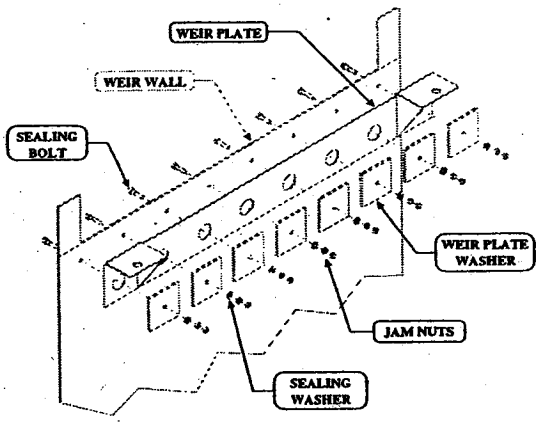
The influent plumbing must be the same size as the nozzle size on the equipment for a minimum of 20 pipe diameters. Do not reduce the size of the influent piping as this might cause inappropriate velocities before it enters the clarifier. Also, try to run the inlet piping as short a distance as possible, through as few changes of direction as possible and at a pitch of not less that 1/16" per foot.

CONNECT THE SLUDGE DRAW-OFF PLUMBING

Connect a valve to the sludge draw-off flange and run a short length of pipe to a place where the sludge can be periodically decanted. When selecting a valve make sure that it is suitable for use with the type of sludge collected in your clarifier.

Plumb up all sludge draw off nozzles for best evacuation of accumulated sludge. This includes the fittings on both sides of the clarifier.

WEIR PLATE INSTALLATION



Step 1. Remove clarifier lid(s) if supplied.

Step 2. Install the weir plate on the weir wall with the sealing bolt's. Be sure to position the weir mounting bolts so the bolt heads are inside the plate pack chamber, and the weir plate and plate washers are in the effluent chamber. This will prevent interference of the bolts and plates with installation of the plate pack.

Step 3. Install weir plate washers.

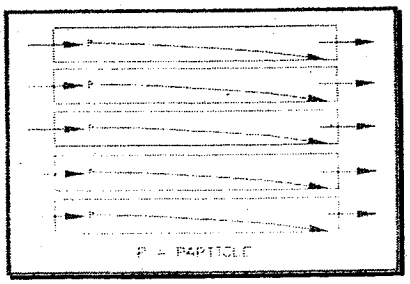
Step 4. Install sealing washer and jam nuts. Hand tighten nuts only.

Step 5. Adjust weir plates to provide a uniform and level depth of liquid flow over the weirs.

PRINCIPAL OF OPERATION

Inclined plate clarifiers are devices that permit the removal of solids particles in a wastestream by allowing them to settle out of the hydraulic flow path of a clarifier thereby extracting them from the wastewater flow. In theory, the flow through velocity (V) of a vessel is determined based upon flow rate (gpm) and vessel size. This is then applied against the settling velocity (P) of a particle and the depth (D) of the vessel. If the resulting calculated trajectory (T) of a given particle will allow it to settle to the bottom before it reaches the vessel's exit, it is removed. This is an adaptation of Stokes Laws of terminal velocity.

The settling process can be accomplished and enhanced in a variety of ways and with a variety of equipment configurations. One common way to improve settling efficiency without increasing the need for floor space is to install a multiple plate pack which will create many settling chambers in one vessel each with a shallow depth. This is done by adding a series of appropriately spaced plates. The flow is distributed to the plates and the simple settling theory is applied. The advantage of multiple plates is that settling area is increased without increasing floor space.

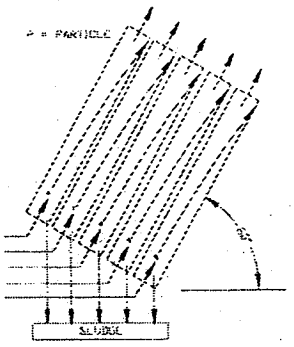


Multiple Plate Pack

The most efficient inclined plate clarifiers are designed to exploit Stokes laws of terminal velocity for a given particle. In order for a particle to be removed according to Stokes laws, the clarifier must conform to several critical design criteria such as:

- Laminar flow conditions must be achieved (Reynolds "Re" number less than 500) in order to allow a particle to settle.
- Hydraulic flow path must distribute influent AND effluent flow in such a way as to ensure complete utilization of the settling surface area in order to take full advantage of the plate pack settling surface area.
- Design of the flow distribution must be such as to prevent any hydraulic short circuiting of the plate pack, which would be detrimental.
- Hydraulic flow-through velocities in the clarifier must not exceed the settling rate of the particles.
- Settling surface area must not become clogged during use, which would adversely alter flow characteristics, possibly creating hydraulic short circuiting and increasing the "Re" number past 500.
- If inclined plates are used, they must be at the proper angle of repose to allow solids to settle in a liquid medium (ideally 55-60 degrees from horizontal) , and they must be smooth enough to allow the unhindered migration of a particle to the bottom of the plate where it will exit the wastestream.

There are several important factors to consider in efficient inclined plate clarifier design. As stated earlier, the inclined plate must have a smooth surface in order to allow unhindered migration of the particle to the bottom of the pack. Another enhancement is to use corrugated plates. Corrugated plates offer the advantage of providing valleys where the settled particles can agglomerate. As the particles gather in the valleys and begin to migrate toward the bottom of the plate pack, they will collide and coalesce with other particles that may be traveling more slowly downward or traveling upward. This will have the effect of entangling discrete particles, thus creating larger discrete particles with increased mass which improves their settling rate.



Inclined Plate Pack

Hydro-Flo Technologies employs inclined plate clarifiers in a most efficient manner. We use ultra-smooth surface, corrugated plates, that are arranged at a 60 degree angle of inclination. This promotes self- flushing and efficient particle agglomeration, which improves the migration of sludge to the bottom of the plate pack and out of the wastestream into the sludge settling chamber. Our influent and effluent flow distribution systems are carefully designed to ensure efficient, even and complete usage of the entire plate pack and to prevent short circuiting. In summary, our clarifiers are thoughtfully designed to ensure reliability and performance. We also offer custom design services to meet specific requirements.

SLUDGE REMOVAL

Please consult your local city and state regulatory agency regarding specific requirements on the proper disposal of the sludge generated in your process.

If you need help with the disposal or treatment of the collected sludge, please contact your local HYDRO-FLO TECHNOLOGIES representative.

Sludge removal is very important to the proper operation of your clarifier. Draw off the settled sludge regularly. Do not allow it to accumulate.

If left unmaintained, the sludge level will rise to a point where it will interfere with the operation of the plate pack. Any settled sludge should be drawn off periodically according to the accumulation rate, typically at the beginning or end of each shift. This will prevent any major sludge related maintenance problems.

If your system was supplied with a sludge auger/thickener it should be allowed to operate continuously or nearly continuously as it will assist in preventing the sludge from naturally compacting in the sludge chamber

EFFLUENT QUALITY

Regularly check the effluent quality of your clarifier. If you notice any loss in effluent quality, take steps to correct the situation immediately. Some areas to check if your effluent quality has deteriorated are:

1. Have you exceeded the clarifier's rated flow?
2. Has the influent characteristics changed due to some process change upstream?
3. Are you chemically treating before the clarifier and if so have these chemicals changed?
4. Are the chemicals being used for treatment completely mixed and are they fresh?
5. Are the chemical injection pump(s) operating properly and injecting at the proper rate?
6. Has the sludge collected to the point where it has begun to blind out the plate pack ?
7. Have you introduced anything new or foreign into the waste stream?

Contact HYDRO-FLO TECHNOLOGIES or your chemical representative for any additional information.

CLARIFIER MAINTENANCE

COATING MAINTENANCE

Touch up all damaged coatings immediately. Regularly inspect the coatings for damage or degradation and repair immediately to prevent severe damage. See the specification information for this particular piece of equipment for proper procedures for coatings touchups for the coatings applied to this equipment. Pay particular attention to coatings condition and perform touchups after installation of any accessory equipment such as mixers, electrical, and media plate packs.

Carbon Steel Interior Surfaces (Standard Coatings)

All interior surfaces are sandblasted to an SSPC-SP10, near white metal blast and then coated with 2 coats of a self-priming coal tar epoxy paint (16 DMT). If maintained properly the surfaces will last the life of the clarifier.

Carbon Steel Exterior Surfaces (standard coatings)

All exterior surfaces are sandblasted to an SSPC-SP6, commercial blast and then coated with one coat of self-priming epoxy paint (6 DMT).

RECOMMENDED PERIODIC MAINTENANCE TABLE

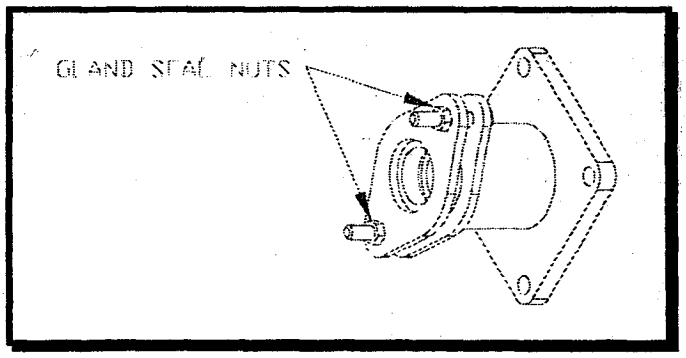
NOTE: Drain the clarifier annually if possible and give it a thorough inspection inside and out. Repair any damaged coatings per the manufacturer's recommendations.

TASK	RECOMMENDED MAINTENANCE SCHEDULE
Check chemical supplies (if used) and replenish as needed.	AS REQUIRED Daily if possible.
Remove accumulated sludge from the sludge collection chamber.	AS REQUIRED Daily if possible.
Check for proper operation of the sludge auger/thickener (if supplied)	AS REQUIRED Daily if possible.
Check auger drive shaft seal Tighten enough to eliminate leaking	AS REQUIRED Weekly if possible.
Check oil levels Auger Drive & Mixer Gearboxes	AS REQUIRED Daily if possible
Remove plate pack and clean	AS REQUIRED. Depending on build up. Typically annually

MECHANICAL SYSTEMS MAINTENANCE

SAFETY FIRST! Never perform any work or make any adjustments to ANY mechanical or electrical system without first securing power to the unit or serious injury can result.

If the unit comes equipped with a sludge auger/thickener device it will be powered by an electric motor connected to a gear box for speed reduction to the auger shaft. The gear box is an oil bath type and will require periodic inspection and maintenance to ensure proper operation. The auger shaft enters the clarifier tank directly adjacent the auger drive motor. The shaft incorporates a stuffing box type seal with a compression plate and two mounting studs with gland seal nuts. The stuffing box seal will wear over time and begin to drip excessive water from the clarifier tank. The stuffing box seal will require tightening of the gland seal nuts to reduce leaking. When you tighten the gland seal nuts you must tighten them no more than ½ turn each and check for leaking while the shaft is turning. Never tighten more than ½ turn without checking for leaking. The shaft seal is seepage lubricated and should seep approximately 6 drips per minute.



Sludge Auger/Thickener Drive Unit

LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

MANUFACTURER WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE. EXCEPT AS EXPRESSLY HEREIN PROVIDED THE GOODS ARE SOLD "AS IS", THE ENTIRE RISK AS TO QUALITY AND FITNESS FOR A PARTICULAR PURPOSE, AND PERFORMANCE OF THE GOODS IS WITH THE BUYER, AND SHOULD THE GOODS PROVE DEFECTIVE FOLLOWING THEIR PURCHASE, THE BUYER AND NOT THE MANUFACTURER, DISTRIBUTOR, OR RETAILER ASSUMES THE ENTIRE RISK OF ALL NECESSARY SERVICING OR REPAIR.

Some jurisdictions do not allow the exclusion or limitation of implied warranties of merchantability and fitness for a particular purpose, of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last or require you to pay certain expenses as set forth above. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

The telephone number of our service and repair facilities central directory, from which you can obtain the locations of our service and repair facilities is, 1-800-333-1366.

GRUNDFOS®

Leaders in Pump Technology

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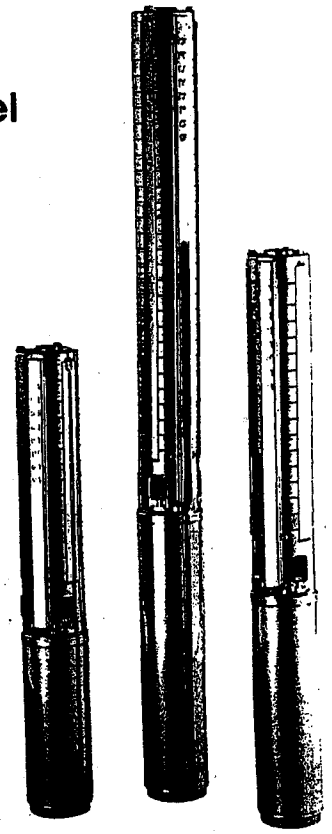
SP4"

Installation and Operating Instructions

4-Inch Stainless Steel Submersible Pumps



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Please leave these instructions with the pump for future reference.

GRUNDFOS®

Leaders in Pump Technology

SAFETY WARNING

Electrical Work

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

Pre-Installation Checklist

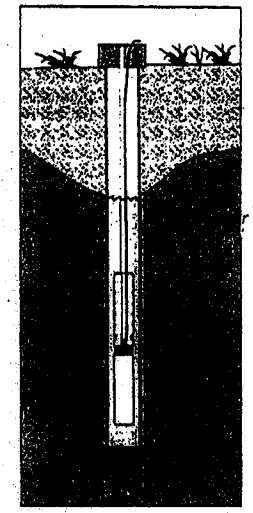
1. Well Preparation

If the pump is to be installed in a new well then the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersibles make it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

2. Make Sure You Have The Right Pump

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.



3. Pumped Fluid Requirements

CAUTION: Submersible well pumps are designed for pumping clear, cold water; free of air or gases. Decreased pump performance and life expectancy can occur if the water is not cold, clear or contains air or gasses. Water temperature should not exceed 102°F.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well. The bottom of the motor should never be installed lower than the top of the screen or within five feet of the well bottom.

Ensure that the requirement for minimum flow past the motor is met, as shown in the table below:

Minimum Water Flow Requirements for Submersible Pump Motors

MINIMUM DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. GPM FLOW PASSING THE MOTOR
4-inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES:

a. For Franklin Motors Only: A flow inducer or sleeve must be used if the water enters the well above the motor or if there is unsufficient water flow past the motor.

b. For Franklin Motors Only: The minimum water velocity over 4" motors is 0.25 feet per second.

c. Grundfos 4" submersible motors do not require a minimum flow or flow sleeve.

4. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight. There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable.

Examine the motor cable and drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation. Insert a properly sized Sta-kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire. Use a good quality tape such as ***#33 Scotch Waterproof*** or ***Plymouth Rubber Company Slipknot Grey***. Wrap each wire and joint tightly for a distance of about 2-1/2 inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

Installation Procedures

1. Attach the Pump to the Pipe

A back-up wrench should be used when riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. Under no circumstances grip the body of the pump, cable guard or motor. When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump. After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump. When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only. It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to ensure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that points are fastened, we recommend the use of a torque arrestor when using plastic pipe.

Do not connect the first plastic riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber. The threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber when tightened down.

2. Lower the Pump Into the Well

Make sure the electrical cables are not cut or damaged in any way when the pump is being lowered in the well. Do not use the power cables to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade utilizing a locally approved well seal or pitless adaptor unit. We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

The drop cable should be secured to the riser pipe at approximately every 10 ft/3 m to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

Figure 1

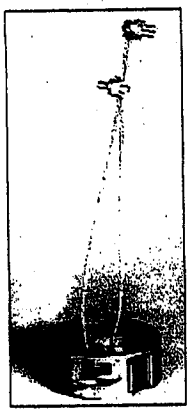


Figure 2

***IMPORTANT:** Plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable. (See Figures 1 & 2.)*

Check Valves: A check valve should always be installed at the surface of the well and one at a maximum of 25 feet above static water level. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

3. Electrical Connections

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor electrical data can be found on page 6. If voltage variations are larger than ± 10%, do not operate the pump. Single-phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor. The type of wire used between the pump control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

A high-voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrestor should be installed on the supply (line) side of the control box or starter (See Figure 3a & 3b). The arrestor must be grounded in accordance with the National Electric Code and local governing regulations.

PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.

The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations. The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be as short a distance as possible and securely fastened to a true grounding point. True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, then to the termianl in the control box.

Single Phase Hookup

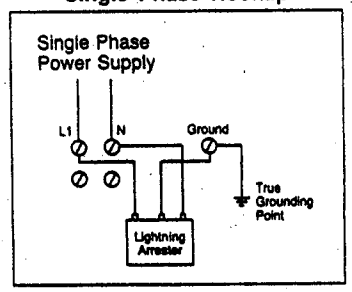


Figure 3a

Three Phase Hookup

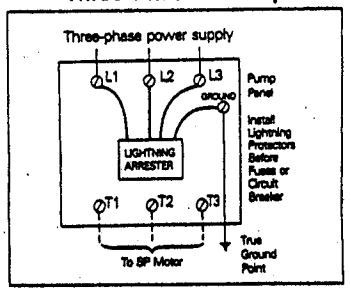


Figure 3b

Single-Phase 2-Wire Wiring Diagram for Submersible Motors

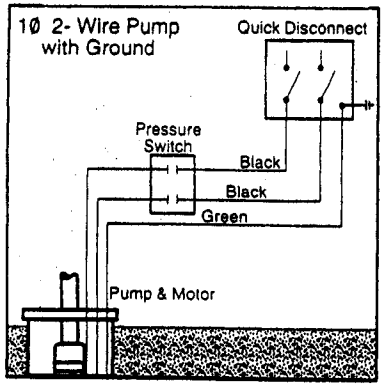


Figure 4

Three-Phase Wiring Diagram for Submersible Motors

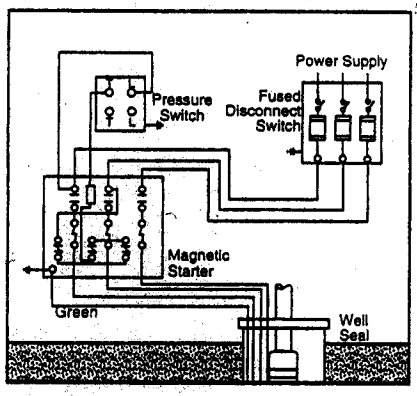


Figure 5

Single-Phase 3-Wire Control Box for Submersible Motors

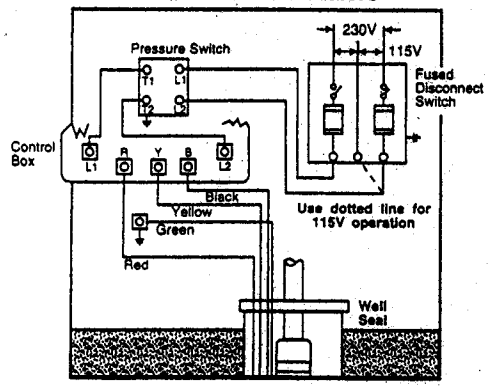


Figure 6

4. Starting the Pump for the First Time

A. Attach a temporary horizontal length of pipe to the riser pipe.
B. Install a gate valve and another short length of pipe to the temporary pipe.
C. Adjust the gate valve one-third of the way open.
D. Verify that the electrical connections are in accordance with the wiring diagram.
E. After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.
F. Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.
G. If the water is clean and clear when the pump is first started, the valve should still be opened until it is all the way open.

Electrical Data

Submersible Pump Motors - 60Hz

GRUNDFOS MOTORS

HP	Ph	Volt	S.F.	Circ. Brkr or Fuses		Amperage		Full Load Eff.	Full Load Pwr Fact.	Max. Thrust	Line-to-Line Resistance (Ohms)		KVA Code	3-Ph. Overload Protection	
				Std.	Delay	Start	Max.	(%)		(lbs)	Blk-Yel	Red-Yel	**	Starter Size	Furnas Amb. Comp
4-Inch, Single Phase, 2-Wire Motors (control box not required)															
1/3	1	230	1.75	15	5	25.7	4.6	59	77	750	6.8-8.2		S	-	-
1/2	1	230	1.60	15	7	34.5	6.0	62	76	750	5.2-6.3		R	-	-
3/4	1	230	1.50	20	9	40.5	8.4	62	75	750	3.2-3.8		N	-	-
1	1	230	1.40	25	12	48.4	9.8	63	82	750	2.5-3.1		M	-	-
1-1/2	1	230	1.30	35	15	62.0	13.1	64	85	750	1.9-2.3		L	-	-
4-Inch, Single Phase, 3-Wire Motors															
1/3	1	230	1.75	15	5	14.0	4.6	59	77	750	6.8-8.3	17.3-21.1	L	-	-
1/2	1	230	1.60	15	7	21.5	6.0	62	76	750	4.7-5.7	15.8-19.6	L	-	-
3/4	1	230	1.50	20	9	31.4	8.4	62	75	750	3.2-3.9	14-17.2	L	-	-
1	1	230	1.40	25	12	37.0	9.8	63	82	750	2.6-3.1	10.3-12.5	K	-	-
1-1/2	1	230	1.30	35	15	45.9	11.6	69	89	750	1.9-2.3	7.8-9.6	H	-	-
4-Inch, Three Phase, 3-Wire Motors															
1-1/2	3	230	1.30	15	8	40.3	7.3	75	72	750	3.9		K	0	K41
		460	1.30	10	4	20.1	3.7	75	72	750	15.9		K	0	K32
		575	1.30	10	4	16.1	2.9	75	72	750	25.2		K	0	K28
2	3	230	1.25	20	10	48	8.7	76	75	750	3.0		J	0	K50
		460	1.25	10	5	24	4.4	76	75	750	12.1		J	0	K34
		575	1.25	10	4	19.2	3.5	76	75	750	18.8		J	0	K31
3	3	230	1.15	30	15	56	12.2	77	75	1000	2.2		H	0	K54
		460	1.15	15	7	28	6.1	77	75	1000	9.0		H	0	K37
		575	1.15	15	6	22	4.8	77	75	1000	13.0		H	0	K36
5	3	230	1.15	40	25	108	19.8	80	82	1000	1.2		H	1	K61
		460	1.15	20	12	54	9.9	80	82	1000	5.0		H	0	K50
		575	1.15	15	9	54	7.9	80	82	1000	7.3		H	0	K43
7-1/2	3	230	1.15	60	30	130	25.0	81	82	1000	0.84		H	1	K67
		460	1.15	35	15	67	13.2	81	82	1000	3.24		J	1	K56
		575	1.15	30	15	67	10.6	81	82	1000	5.2		J	1	K53

*All Grundfos 4" motors have a ground (green wire)

(Refer to the Franklin Submersible Motors Application Maintenance Manual)

Motor Information

Maximum Cable Length
Motor Service to Entrance
(Length in feet)

Single-Phase 60 Hz

MOTOR RATING		COPPER WIRE SIZE								
VOLTS	HP	14	12	10	8	6	4	2	0	00
115	1/3	130	210	340	540	840	1300	1960	2910	
	1/2	100	160	250	390	620	960	1460	2160	
230	1/3	550	880	1390	2190	3400	5250	7960		
	1/2	400	650	1020	1610	2510	3880	5880		
	3/4	300	480	760	1200	1870	2890	4370	6470	
	1	250	400	630	990	1540	2380	3610	5360	6520
	1-1/2	190	310	480	770	1200	1870	2850	4280	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120	190	300	470	750	1190	1850	2890	3610
	5			180	280	450	710	1110	1740	2170

Three-Phase 60 Hz

VOLTS	HP	14	12	10	8	6	4	2
208	1-1/2	310	500	790	1260			
	2	240	390	610	970	1520		
	3	180	290	470	740	1160	1810	
		5170	280	4690	1080			1660
230	1-1/2	360	580	920	1450			
	2	280	450	700	1110	1740		
	3	210	340	540	860	1340	2080	
	5		200	320	510	800	1240	1900
460	1-1/2	1700						
	2	1300	2070					
	3	1000	1600	2520				
	5	590	950	1500	2360			
575	1-1/2	2620						
	2	2030						
	3	1580	2530					
	5	920	1480	2330				

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

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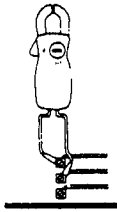
Pump Model & Stages	Temp °C	Temp °F	Water Contact Volume in Liters for Highest Number of Stages	Contact Volume in Gallons for Highest Number of Stages	Minimum Submergence in Feet for Highest Number of Stages 4" Well ID
5S					
9-26	30	86	26	7	11
31-48	30	86	37	10	15
7S					
8-26	30	86	26	7	11
10S					
6-27	30	86	27	8	11
34-48	30	86	37	10	15
58	30	86	45	12	18
16S					
5-24	30	86	25	7	10
38	30	86	30	8	12
56-75	30	86	58	16	24
25S					
3-26	30	86	26	7	11
39	30	86	26	7	11
52	30	86	40	11	17
40S					
3-44	30	86	268	71	109
50-66	30	86	401	106	162
60S					
4-18	30	86	35	9	14
75S					
3-16	30	86	31	8	13

Troubleshooting

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter. On single-phase units, measure between line and neutral.

What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT

How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See page 6, for motor amp draw information.

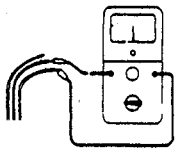
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
2. Too high or low supply voltage.
3. Motor windings are shorted.
4. Pump is damaged causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.

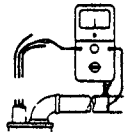
Zero-adjust the meter and measure the resistance between leads. Record the values. Motor resistance values can be found on page 6.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values on page 6.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zero-adjust the meter. Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting

Pump Won't Start

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
No power at the motor	Check for voltage at the control box or panel.	If there is no voltage at the control panel, check the feeder panel for tripped circuits and reset those circuits.
Fuses are blown or the circuit breakers have tripped	Turn off the power and remove the fuses. Check for continuity with an ohmmeter.	Replace the blown fuses or reset the circuit breaker. If the new fuses blow or the circuit breaker trips, the electrical installation, motor, and wires must be check for defects.
(3-phase motors only) **Motor starter overloads are burned or have tripped**	Check for voltage on the line and load side of the starter. Check the amp draw and make sure the heater is sized correctly.	Replace any burned heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage. Ensure that heaters are sized correctly and the trip setting is appropriately adjusted.
(3-phase motors only) **Starter does not energize**	Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit fuses. If there is voltage, check the holding coil for weak connections. Ensure that the holding coil is designed to operate with the available control voltage. Replace the coil if defects are found.
Defective controls	Check all safety and pressure switches for defects. Inspect the contacts in control devices.	Replace worn or defective parts or controls.
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K).	If an open or grounded winding is found, remove the motor from the well and recheck the measurements with the lead separated from the motor. Repair or replace the motor or cable.
(1-phase motors only) **Defective capacitor**	Turn off the power and discharge the capacitor by shorting the leads together. Check it with an analog ohmmeter (set to R x 100k).	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (∞). Replace capacitor if it is defective.
Defective pressure switch or the tubing to it is plugged	Watch the pressure gauges as the pressure switch operates. Remove the tubing and blow through it.	Replace as necessary.
The pump is mechanically bound or stuck	Turn off the power and manually rotate the pump shaft. Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor).	If the pump shaft doesn't rotate, remove the pump and examine it. If necessary, dismantle it and check the impellers and seal for obstruction. Check for motor corrosion.

Pump Does Not Produce Enough Flow (GPM)

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
(3-phase motors only) **Shaft is turning in the wrong direction**	Check to make sure the electrical connections in the control panel are correct.	Correct the wiring. For single phase motors, check the wiring diagram on the motor. For three phase motors, simply switch any two power leads.
Pump is operating at the wrong speed (too slow)	Check for low voltage and phase imbalance.	Replace defective parts or contact power company, as applicable.
Check valve is stuck (or installed backwards)	Remove the check valve.	Re-install or replace.
Parts or fittings in the pump are worn **– or –** **Impellers or Inlet Strainer is clogged**	Install a pressure gauge near the discharge port, start the pump, and gradually close the discharge valve. Read the pressure at shutoff. (Do not allow the pump to operate for an extended period at shutoff.)	Convert the PSI you read on the gauge to Feet of Head by: $\frac{\text{PSI x 2.31 ft/PSI}}{\text{Specific Gravity}} = \_\_\_\_\_ \text{ ft.}$ Add to this number the number of feet (vertically) from the gauge down to the water's pumping level. Refer to the pump curve for the model you are working with to determine the shutoff head you should expect for that model. If that head is close to the figure you came up with (above), the pump is probably OK. If not, remove the pump and inspect impellers, chambers, etc.
The water level in the well may be too low to supply the flow desired **– or –** **Collapsed well**	Check the drawdown in the well while the pump is operating.	If the pumping water level (including drawdown) is not **AT LEAST 3 FEET** above the pump's inlet strainer, either: 1. Lower the pump further down the well. 2. Throttle back the discharge valve to decrease the flow, thereby reuding drawdown.
Broken shaft or coupling	Pull pump and inspect.	Replace as necessary.
There are leaks in the fittings or piping	Pull the pump out of the well.	The suction pipe, valves, and fittings must be made tight. Repair any leaks and retighten all loose fittings.

Fuses Blow or Heaters Trip

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
Improper voltage	Check the voltage at the control box or panel.	If the voltage varies by more than 10% (+ or -), contact the power company.
	If the incoming voltage is OK, check the wire size and the distance between the pump motor and the pump control panel.	Rewire with correct gauge. Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor.
The starter overloads are set too low	Cycle the pump and measure the amperage.	Increase the heater size or adjust the trip setting. Do not, however, exceed the recommended rating.
(3-phase motors only) The three-phase current is imbalanced	Check the current draw on each lead to the motor.	The current draw on each lead must be within 5% of each other (+ or -). If they are not, check the wiring.
The wiring or connections are faulty	Check to make sure the wiring is correct and there are no loose terminals.	Tighten any loose terminals and replace any damaged wire.
(1-phase motors only) Capacitor is defective	Turn off the power and discharge the capacitor. Check the capacitor with an ohmmeter (set at R x 100k). See page 15 for instructions.	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and then slowly drift back to infinity (∞). Replace capacitor if it is defective.
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts.	Replace as necessary.
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day – you should be able to keep your hand on it without burning.	Shade, ventilate, or move the control box so its environment does not exceed 120°F.
(1-phase motors only) Wrong control box	Check requirements for the motor against the control box specifications.	Replace as necessary.
Defective pressure switch	Watch gauges as pressure switch operates.	Replace as necessary.
The motor is shorted or grounded.	Turn off the power and disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K) or a megaohmmeter. Compare these measurements to the rated values for your motor.	If you find an open or grounded winding, remove the motor and recheck the leads. If OK, check the leads for continuity and for bad splice.
Poor motor cooling	Find the internal diameter of the well casing (or sleeve, if used). For proper cooling, the flow of water must not be less than the GPM shown across the bottom scale on page ___.	Throttle up the pump flow (GPM) so proper cooling is possible. – or – Pull the pump out of the well and add a sleeve with a smaller internal diameter.

Pump Cycles Too Often

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
The pressure switch is defective or is not properly adjusted	Check the pressure setting on the switch. Check the voltage across closed contacts.	Readjust the pressure switch or replace it if defective.
The tank is too small	Check the tank size and amount of air in the tank. The tank volume should be approximately 10 gallons for each Gallon-Per-Minute of pump capacity. At the pump cut-in pressure, the tank should be about 2/3 filled with air.	Replace the tank with one that is the correct size.
There is insufficient air charging of the tank or piping is leaking	Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soapy water. Check the air-to-water ratio in the tank.	Repair as necessary.
Plugged snifter valve or bleed orifice (causing pressure tank to be waterlogged)	Examine them for dirt or erosion.	Repair or replace as necessary.
Leak in the pressure tank or piping	Apply soapy water to pipes and tank, then watch for bubbles, indicating leaks.	Repair or replace as necessary.
The level control is defective or is not properly set	Check the setting and operation of the level control.	Readjust the level control setting (according to the manufacturer's instructions) or replace it if defective.
Pump is oversized for the application. It is outpumping the yield of the well and pumping itself dry.	Check the yield of the well (determined by the well-test) against the pump's performance curve.	Reduce the flow by throttling back the valve. – or – Change the pump.

INSTRUCTIONS

for

INSTALLATION - OPERATION

and

MAINTENANCE

of

CLASS SMP

1000 SERIES

2000 SERIES

3000 SERIES

HORIZONTAL

MOTORPUMPS

Note: It is important that the entire contents of this booklet be studied before installation.

Ingersoll-Dresser Pumps

TABLE OF CONTENTS

WARNING

OBSERVE EXTREME CAUTION WHEN VENTING AND/OR DRAINING HAZARDOUS LIQUIDS. WEAR PROTECTIVE CLOTHING IN THE PRESENCE OF CAUSTIC, CORROSIVE, VOLATILE, FLAMMABLE, OR HOT LIQUIDS. DO NOT BREATHE TOXIC VAPORS. DO NOT ALLOW SPARKING, FLAMES, OR HOT SURFACES IN VICINITY OF THE EQUIPMENT.

NOTE: IT IS IMPORTANT THAT THE ENTIRE CONTENTS OF THIS BOOKLET BE STUDIED BEFORE INSTALLATION.

FOREWORD

Do not install this equipment other than in accordance with the instructions contained in this manual.

The descriptions and instructions in this manual cover the standard design of the equipment and the more popular options when possible. This manual does not cover all design details and variations, nor does it provide for every contingency which may be encountered. When information cannot be found in this manual, contact the nearest Ingersoll-Dresser Pumps branch office.

This instruction book should be read completely before starting installation. The equipment is capable of trouble-free operation when properly installed, operated, and maintained. These instructions present the basic information and methods required for proper installation and maintenance.

This pump has been designed to provide safe and reliable service. However, it is both a pressure vessel and a piece of rotating machinery. Therefore, the operator(s) must exercise good judgment and proper safety practices to avoid damage to the equipment and surroundings and prevent personal injury. The instructions in this manual are intended for personnel with a general training in operation and maintenance of centrifugal pumps.

SAFETY

It is assumed that your safety department has established a safety program based upon a thorough analysis of industrial hazards. Before installing and operating or performing maintenance on the pump and associated components described in this manual, it is suggested that the safety program be reviewed to ensure that it covers the hazards arising from high speed rotating machinery.

It is also important that due consideration be given to those hazards which arise from the presence of electrical power, hot oil, high pressure and temperature liquids, toxic liquids and gases, and flammable liquids and gases. Proper installation and care of protective guards, shutdown devices and over pressure protection equipment should also be considered an essential part of any safety program.

Also essential are special precautionary measures to prevent the possibility of applying power to the equipment at any time when maintenance work is in progress. The prevention of rotation due to reverse flow should not be overlooked.

In general, all personnel should be guided by all the basic rules of safety associated with the equipment and the process.

It should be understood that the information contained in this manual does not relieve operating and maintenance personnel of the responsibility of exercising normal good judgment in operation and care of the pump and its components.

INSTALLATION, OPERATION AND MAINTENANCE SAFETY PROCEDURES

In the following procedure you will encounter the words WARNING, CAUTION AND NOTE. These are intended to emphasize certain areas in the interest of personal safety and satisfactory pump operation and maintenance. The definitions of these words are as follows:

WARNING: An operating procedure, practice, etc. which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION: An operating procedure, practice, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE: An operating procedure, condition, etc. which is essential to highlight.

These safety procedures are to be used in conjunction with the installation, operation and maintenance instructions contained in the pump manual.

Ingersoll-Dresser Pumps reserves the right to change the design, construction, or material of any part without incurring the obligation of installing such changes on pumps already delivered.

NOTE: Reference is made throughout this manual to 1000 Series, 2000 Series, and 3000 Series Pumps. Listed below are the pumps belonging to each series.

1000 SERIES	2000 SERIES	3000 SERIES
1x4	¾x5 1x5	3x5 1x7
1¼x4	¾x6 1¼x5	3x6 1½x7
1½x3	1½x5	2x7

NOTE: The design of piping system, foundations, and other areas of system design is the responsibility of others. Ingersoll-Dresser Pumps data and comments are offered as an aid, but IDP cannot assume responsibility for the design and operation. We recommend that the customer consult a specialist skilled in the design of foundations, piping, sumps and related systems so as to supplement and interpret Ingersoll-Dresser Pumps' information and ensure a successful installation.

INSTALLATION

CHECK UPON ARRIVAL

The unit should be inspected immediately upon arrival, and any irregularities arising due to shipment should be reported to the carrier.

It is possible that excessively rough handling in shipment has caused binding of the internal parts of the pump. Before installing the pump, check for freedom of rotation. If binding has occurred, loosen the casing bolts and shift the parts until the binding is eliminated.

STORAGE

The pump is protected against contamination for the period of shipment and installation only.

If the pump is not to be installed at once, find a clean, dry location for storage. Unit should be stored in an approximately level position with no strains applied. Protective coverings should be left in place. The pump should be left in its shipping container or skid for storage.

HANDLING

Use care when moving pumps. Rough handling of the pump can cause breakage or permanent misalignment.

Make sure that any equipment used to lift the pump or any of its components is capable of supporting the weights encountered. Make sure that all parts are properly rigged before attempting to lift.

LOCATION

Install the pump in an accessible location as close to the source of liquid to be pumped as possible. Care must be taken to provide adequate space for maintenance as well as to eliminate all possibility of heavy objects bumping or falling on the unit.

SMP pumps are designed to be used as horizontal units; however, if circumstances dictate, they may be installed vertically (motor end up). Special auxiliary mounting brackets, available from Ingersoll-Dresser Pumps, must be used to properly support the unit.

NOTE Location of pump should allow easy removal of casing drain and vent plugs as required for maintenance and priming of the pump.

PRESSURE AND TEMPERATURE LIMITATIONS

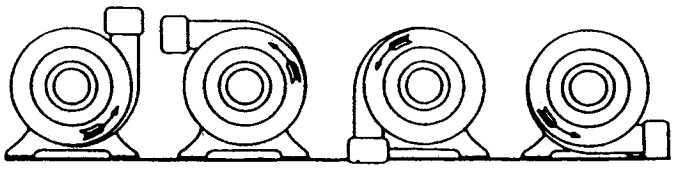
In general these pumps must be put in locations where ambient temperatures are not so excessive as to be detrimental to the operation of the motor, which is rated for operation at 104°F (40°C) continuous duty.

For most operating conditions, the mechanical seal is cooled and lubricated by the liquid being pumped. Standard seals are supplied for suction pressures between 20 inches (50.8 cm) Hg vacuum and 85 psig (5.97 Kg/cm²) positive pressure and liquid temperatures between −30°F (−35°C) and 211°F (99.5°C).

Temperatures greater than 211°F (99.5°C) but less than 250°F (121°C) are acceptable for non-caustic, non-hydrocarbon service but a different seal must be used.

PIPING

The casing of Class SMP Motorpumps can be rotated to any one of the positions shown. To rotate the casing, remove the casing cap screws and rotate to the position desired.



A | B (NOTE 1) | C (NOTE 2) | D (NOTE 1) (NOTE 2)

NOTE 1—Casing and support head must be rotated together.
NOTE 2—Requires raising of the unit to provide clearance for discharge nozzle.

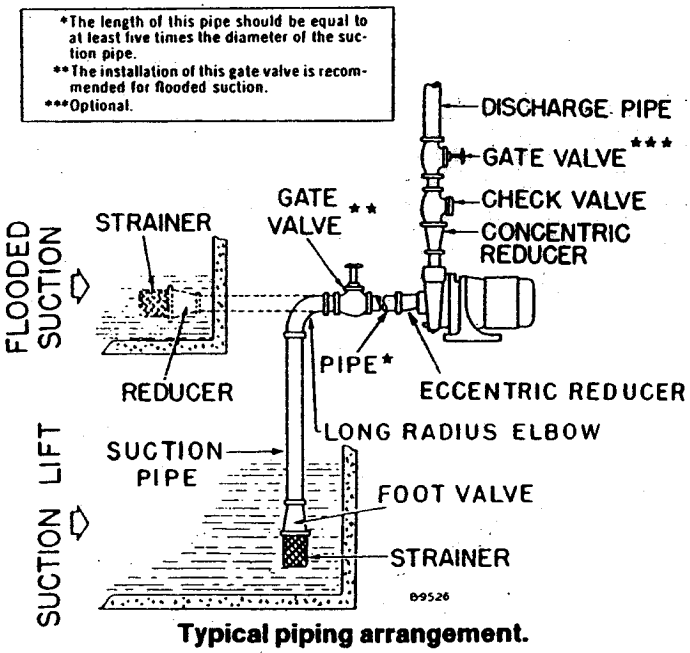
Suction Piping

Install an eccentric reducer at the pump suction opening and make all suction pipe at least one pipe size larger than the diameter of the suction opening. The suction line is to be short and direct with as few elbows as possible. Submerge the suction line at least three feet below the minimum level of the liquid being pumped. The static lift, including all friction losses, must not exceed the NPSH requirements of the pump.

If necessary, install a strainer at the open end of the suction line to prevent foreign matter from entering the pump. The net area of the strainer should be 2 to 3 times larger than the inside area of the suction pipe.

To maintain prime for pumps operating under suction lift, a foot valve must be installed at the opening of the suction line.

Use extreme care in making up suction pipe fittings, since air leaks will cause the pump to lose prime.



Typical piping arrangement.

Discharge Piping

Install a concentric reducer at the pump discharge opening and make all discharge piping one pipe size larger than the diameter of the discharge opening.

Keep friction head to a minimum by making the discharge line short and direct with as few fittings as possible.

Install a gate valve and check valve in the discharge line. The installation of the check valve will prevent back flow which may damage the pump on shut down. Ingersoll-Rand will not assume responsibility for damage resulting from failure to install a check valve in the discharge line.

NOTE If quick-closing valves are installed in the discharge piping system, protection MUST be provided to ensure that no surge or water-hammer is transmitted to the pump.

Piping For Air Conditioning and Dishwashing Service .... Pipe line pulsations can be minimized by observing the following precautions:

Mount the pump on a resilient base.

Connect the suction and discharge to the pump through flexible hose. Hose size at least one size larger than the diameter of the suction and discharge opening should be used and connected to the pump through appropriate concentric and eccentric reducers. Do not form piping loops immediately adjacent to the pump.

To prevent damage to the pump due to back pressure, install a check valve in the discharge line. (Ingersoll-Rand will not assume responsibility for damage resulting from failure to install a check valve.)

Avoid very rigid pipe lines.

For maintenance purposes, install a gate valve in both the suction and discharge line.

WIRING THE MOTOR

Wire the electric motor according to the instructions given on the motor nameplate or the decal attached to the inside of the motor conduit connection cover.

Direction of rotation should be checked by observation of the shaft through the openings in the pump support head. Direction of rotation should be as shown by the arrow on the pump casing. In the event that rotation is incorrect, refer to the motor instructions or nameplate.

OPERATION

CAUTION

WHEN OPERATING FOR SOME TIME AT REDUCED CAPACITY, MUCH OF THE PUMP HORSEPOWER WILL GO INTO THE LIQUID IN THE FORM OF HEAT. A BY-PASS MUST BE PROVIDED UNDER THESE CONDITIONS TO PREVENT THE LIQUID IN THE PUMP FROM BECOMING HOT ENOUGH TO VAPORIZE. DAMAGE TO PUMP MAY RESULT FROM PROLONGED OPERATIONS AT CAPACITIES LESS THAN TEN PERCENT OF THE BEST EFFICIENCY POINT.

WARNING

IN THE INTEREST OF OPERATOR SAFETY THE UNIT MUST NOT BE OPERATED ABOVE THE NAMEPLATE CONDITIONS. SUCH OPERATION COULD RESULT IN UNIT FAILURE CAUSING INJURY TO OPERATING PERSONNEL. CONSULT INSTRUCTION BOOK FOR PROPER OPERATION AND MAINTENANCE OF THE PUMP AND ITS SUPPORTING COMPONENTS. DO NOT USE THIS UNIT ON ANY OTHER SERVICE THAN THAT FOR WHICH IT WAS ORIGINALLY SOLD WITHOUT CHECKING WITH AN INGERSOLL-DRESSER PUMPS REPRESENTATIVE FOR RECOMMENDATIONS.

FREEDOM OF ROTATION

Check for freedom of rotation by momentarily starting the motor and listening for any rubbing sound. If rubbing is detected, check discharge piping to make sure it is not causing strain on the unit.

PRIMING THE PUMP

The casing and suction piping must be completely filled with liquid being pumped before starting.

If the liquid source is above the pump, prime the pump by removing the vent at the top of the casing plug, thus allowing liquid to replace the air trapped in the casing.

If the liquid source is below the pump, prime the pump by injecting liquid into the casing through the vent plug tap or check valve.

NOTE To maintain prime where the liquid source is below the pump, a foot valve must be installed in a vertical position at the open end of the suction line.

STARTING THE PUMP

Investigate the source of liquid supply, and see that the discharge line is properly arranged to handle the liquid pumped. When starting the pump for the first time, and always when there is no pressure in the discharge line, leave the flow control valve in the discharge line closed, or partially open. Start the driver.

Make certain that liquid is always being discharged from the pump. A discharge pressure gauge is the best method to check whether or not liquid is being pumped. If at any time, the gauge should drop to zero or register abnormal pressure, shut down the pump immediately and determine the cause.

STOPPING THE PUMP

Electric motor driven pumps do not require any special shut down procedure.

Close the suction and discharge valves if maintenance work is to be done on the pump.

When the pump is idle and there is a possibility of freezing temperatures, pump should be drained.

In the event that it is necessary to shut down the pump for extended periods of time, precautions should be taken to prevent internal rusting.

TROUBLE CHART

If any of the following troubles are encountered, they may be due to the causes listed below

No liquid delivered:
1. Pump not primed.
2. Speed too low—check motor voltage.
3. Air or gas in liquid.
4. Impeller clogged.
5. Casing or discharge line clogged.
6. Wrong direction of rotation.
7. Discharge valve closed; check valve installed backwards (or stuck).
8. Not enough NPSH available.
9. Discharge head too high (check system head).
10. Casing air or vapor bound.

Not enough liquid delivered:
1. Liquid level in source too low (air vortexing into suction).
2. Speed too low—check motor voltage.
3. Air or gas in liquid.
4. Impeller partially clogged or damaged.
5. Casing or discharge line partially clogged.
6. Wrong direction of rotation.
7. Discharge valve partially closed.
8. Not enough NPSH available.
9. Discharge head too high.
10. Excessive impeller running clearance.
11. Liquid votexing in sump.

Not enough pressure:
1. Liquid level in sump too low (pump casing not properly submerged).
2. Speed too low—check motor voltage.
3. Air or gas in liquid.
4. Wrong direction of rotation.
5. Impeller partially clogged or damaged.
6. Excessive impeller running clearance.
7. Liquid vortexing in sump.

Pump uses too much power:
1. Speed too high.
2. Head lower than rating (allows pump to handle too much liquid).
3. Liquid heavier and more viscous than rating.
4. Rotor binding.
5. Seal binding.
6. Impeller dragging.
7. Wrong direction of rotation.
8. Motor defects.

Excessive vibration:
1. Air or gas in liquid.
2. Badly worn bearings.
3. Bent shaft.
4. Wrong direction of rotation.
5. Impeller plugged or damaged.
6. Pump foundation not rigid.
7. Liquid level in sump too low (pump casing not properly submerged).
8. Not enough NPSH available.
9. Liquid vortexing in sump.

Seal Leaks:
1. Improper assembly.
2. Worn seal faces.
   a. Corrosion due to character of liquid pumped.
   b. Excessive amounts of abrasive material in liquid causing an accumulation around the rotating assembly which results in faces opening up and allowing grit between them.
   c. Seal running dry.

MAINTENANCE

WARNING Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in personal injury to operating personnel.

Before attempting any inspection or repair on the pump the driver controls must be in the "off" position, locked and tagged to prevent injury to personnel performing service on the pump.

PREVENTIVE MAINTENANCE

Ingersoll-Dresser pumps are ruggedly constructed, and with proper care will give years of satisfactory service.

Periodically, depending upon your service schedule, the unit should be dismantled, and all internal parts and passages cleaned and inspected for wear. Any foreign matter found in the pump should be removed, and all excessively worn parts replaced.

Ingersoll-Dresser Pumps assumes no responsibility or liability for damages caused by the use and failure of the pump which has been fitted with spare or repair parts not of Ingersoll-Dresser Pumps' manufacture. Only genuine parts from Ingersoll-Dresser Pumps or an authorized distributor should be used.

DISASSEMBLY

Refer to the pump cross-section drawings for part nomenclature.

It is not necessary to disconnect the suction or discharge piping. Close the valves in the suction and discharge piping, and remove the casing drain plug to allow the unit to drain. Remove the anchor bolts holding the pump/motor feet to its base, and disconnect the wiring from the motor (match-mark leads).

Remove the casing bolts. The entire rotating assembly may now be withdrawn from the casing. Note: If, due to limited access on 1000 Series pumps, it is hard to get at the casing bolts, disassembly may be accomplished by first loosening the set screws holding the stub shaft to the motor shaft, then removing the support head-to-motor bolts, and then removing motor. This allows more room to get at the casing bolts.

While keeping the shaft from rotating, unscrew (counter-clockwise) the impeller bolt. Remove impeller washer. Remove impeller. Note: 1000 Series impeller is threaded to the shaft; unscrew in counter-clockwise direction.

Further disassembly may proceed in either of two ways:

Option 1—Unbolt support head from motor, and remove. This will also remove the mechanical seal stationary and rotating elements along with it. Loosen set screws on 1000 and 2000 Series units, and remove stub shaft. On 3000 Series units, remove shaft sleeve and flinger.

Option 2—Loosen set screws on 1000 and 2000 Series units, and remove stub shaft. The mechanical seal stationary and rotating elements will come along with the stub shaft. On 3000 Series units, remove shaft sleeve. Remove mechanical seal from sleeve/stub shaft. Remove support head.

INSPECTION

Discard O-rings and gaskets, as new ones should be used during reassembly.

All parts should be clean for inspection and reassembly. Wash all parts and spread them out in a clean area. Dry the parts with compressed air or lint-free cloths and carefully inspect them as described below.

Inspect pump components for corrosion, erosion, and wear.

Inspect casing thoroughly, removing all burrs and foreign matter. Check hydraulic passages for cleanliness.

Inspect the impeller vanes and ring fits for wear, erosion, burrs, or scoring. Large nicks and deep pitting will unbalance the impeller and may cause vibration and excessive wear, on other parts of the pump.

Restore or replace all worn or damaged parts. Use new gaskets and O-rings.

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On 2000 and 3000 Series pumps, check front, and back (where applicable), impeller hub running clearances, which should be .015" to .022" diametral clearance. Replace part(s) if diametral clearance exceeds .030".

Check driver shaft runout, which should not exceed .002" T.I.R. Check condition of motor bearings by rotating motor shaft by hand, listening for noise, and observing shaft for excess movement.

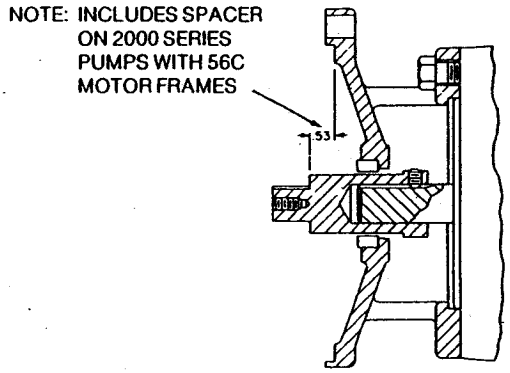
REASSEMBLY

Basically, the pump is reassembled in the reverse order of disassembly. Lightly oil parts to ease assembly and to aid subsequent disassembly.

It is important that all parts are clean and free from burrs prior to reassembly as failure to do so may cause misalignment or damage to the unit.

Stub Shaft Installation —1000 Series Pumps: Install stub shaft onto motor shaft, but do not tighten set screws at this time. Stub shaft will be positioned during procedure on page 8, "Adjust Impeller Running Clearance".

Stub Shaft Installation —2000 Series Pumps: Install stub shaft onto motor shaft. Install mechanical seal stationary member into support head. Install support head to motor. Position stub shaft per sketch below, and tighten set screw(s) to 5 to 6 foot-pounds torque.



NOTE On 1000 Series and 2000 Series Pumps, install stub shaft so that set screws will be in keyway of motor shaft.

Shaft Sleeve Installation—3000 Series Pumps: Install flinger, O-ring, and shaft sleeve onto motor shaft.

Remainder of Assembly—All Series: Install mechanical seal stationary member into support head. Install support head to motor (this procedure has already been done at this point on 2000 Series pumps).

Install mechanical seal rotating member on stub shaft/sleeve.

Install impeller key (2000 and 3000 Series), impeller, impeller washer, and impeller bolt. Note: 2000 Series pumps with 56C frame motors use a spacer sleeve between the impeller and the stub shaft shoulder.

Install casing gasket onto support head. Install assembly into casing.

Use torque values on page 8 for all bolting. Do not overtorque.

	1000 SERIES	2000 SERIES	3000 SERIES
Bolts Support Head to Motor	10 to 15 Foot-Pounds	10 to 15 Foot-Pounds	20 to 25 Foot-Pounds
Bolts Casing to Support Head	25 Foot-Pounds	25 Foot-Pounds	40 Foot-Pounds *
Impeller Capscrew	2 to 4 Foot-Pounds	6 to 8 Foot-Pounds	12 to 15 Foot-Pounds
Set Screws	5 to 6 Foot-Pounds	5 to 6 Foot-Pounds	———

* Except 3x5 and 3x6 pumps, which are torqued to 25 foot-pounds.

ADJUST IMPELLER RUNNING CLEARANCE (1000 Series Pumps)

Make sure set screws holding stub shaft to motor shaft are loose.

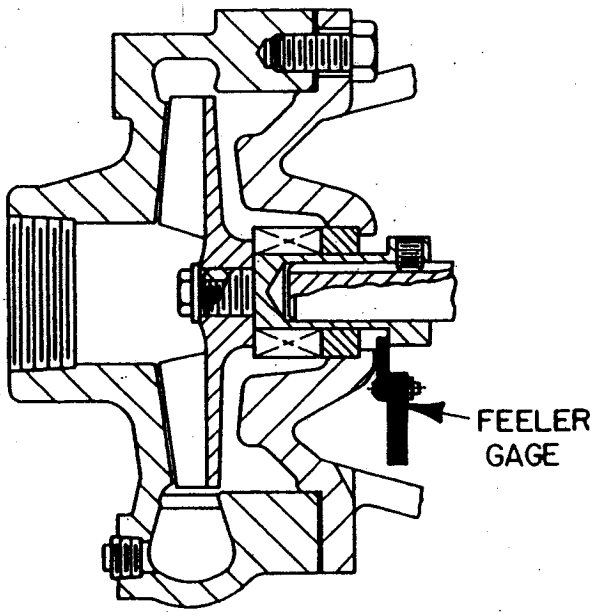
Shove stub shaft forward (towards pump casing) until impeller is touching pump casing.

Insert feeler gage between shoulder on stub shaft and nose of support head (see sketch). Measure gap.

Add .010" to feeler gage, and move stub shaft back (toward motor) until feeler goes in between shoulder on stub shaft and nose of support head.

Tighten set screws to 5 to 6 foot-pounds torque.

Remove feeler gage.



TECHNICAL DATA

NET POSITIVE SUCTION HEAD (NPSH)

Any liquid, hot or cold must be pushed into the impeller of the pump by some absolute pressure, such as the atmosphere or the vessel pressure from which the pump takes its suction.

The head in feet of liquid necessary to maintain the required flow into the pump is called the Net Positive Suction Head. This value, more commonly called NPSH, is measured above the vapor pressure of the liquid at the pumping temperature.

NPSH is commonly expressed in two ways: the NPSH required by the pump, and shown on the pump curve, is the head needed to cover the losses in the pump suction; the NPSH available is that inherent in the system, taking into account friction loss in suction piping, valves, fittings, etc. In all cases, the NPSH available, measured above vapor pressure, must exceed the NPSH required in order to push the liquid into the pump.

CHANGING PUMP SPEED

Changing the speed of a centrifugal pump affects the capacity, total head, NPSH required and the brake horsepower. In general the capacity will vary in a direct ratio with the speed, whereas the total head and NPSH required will vary as the ratio of the speed squared. The brake horsepower will vary as the ratio of the speed cubed.

EFFECTS OF SPECIFIC GRAVITY

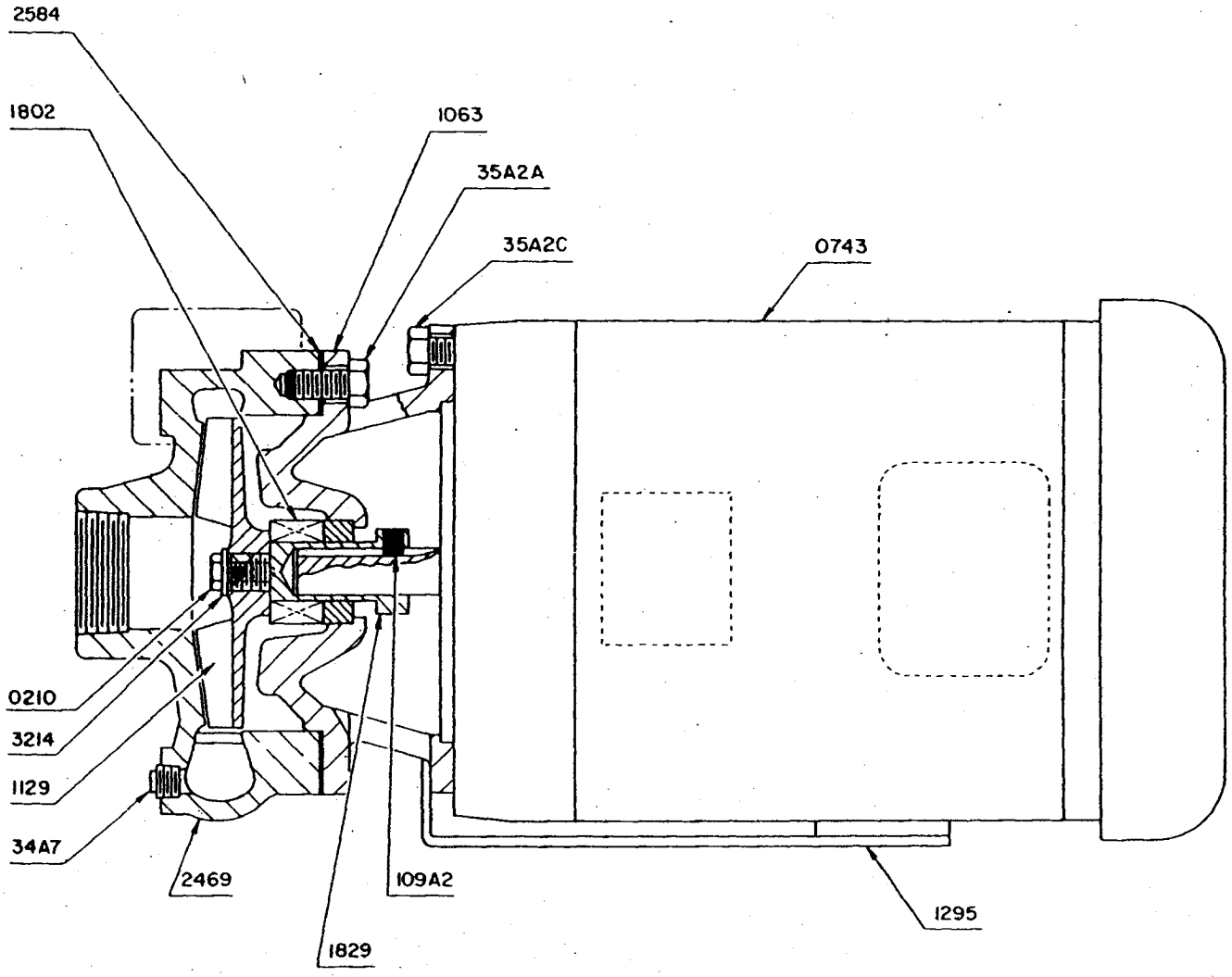
The capacity and total head in feet of liquid developed by a centrifugal pump are fixed for every point on the curve and are always the same for the same speed. Neither capacity nor total head will be affected by a change in the specific gravity of the liquid pumped. However, since the discharge pressure in psi (pounds per square inch) and the brake horsepower required to drive the pump are functions of the specific gravity of the liquid, both will be affected in direct proportion by any change in specific gravity. Therefore, an increase in specific gravity will raise the discharge pressure and is dangerous, as it might overload the pump's driver.

EFFECTS OF VISCOSITY

The pump is designed to deliver rated capacity at rated head for a liquid with a particular viscosity.

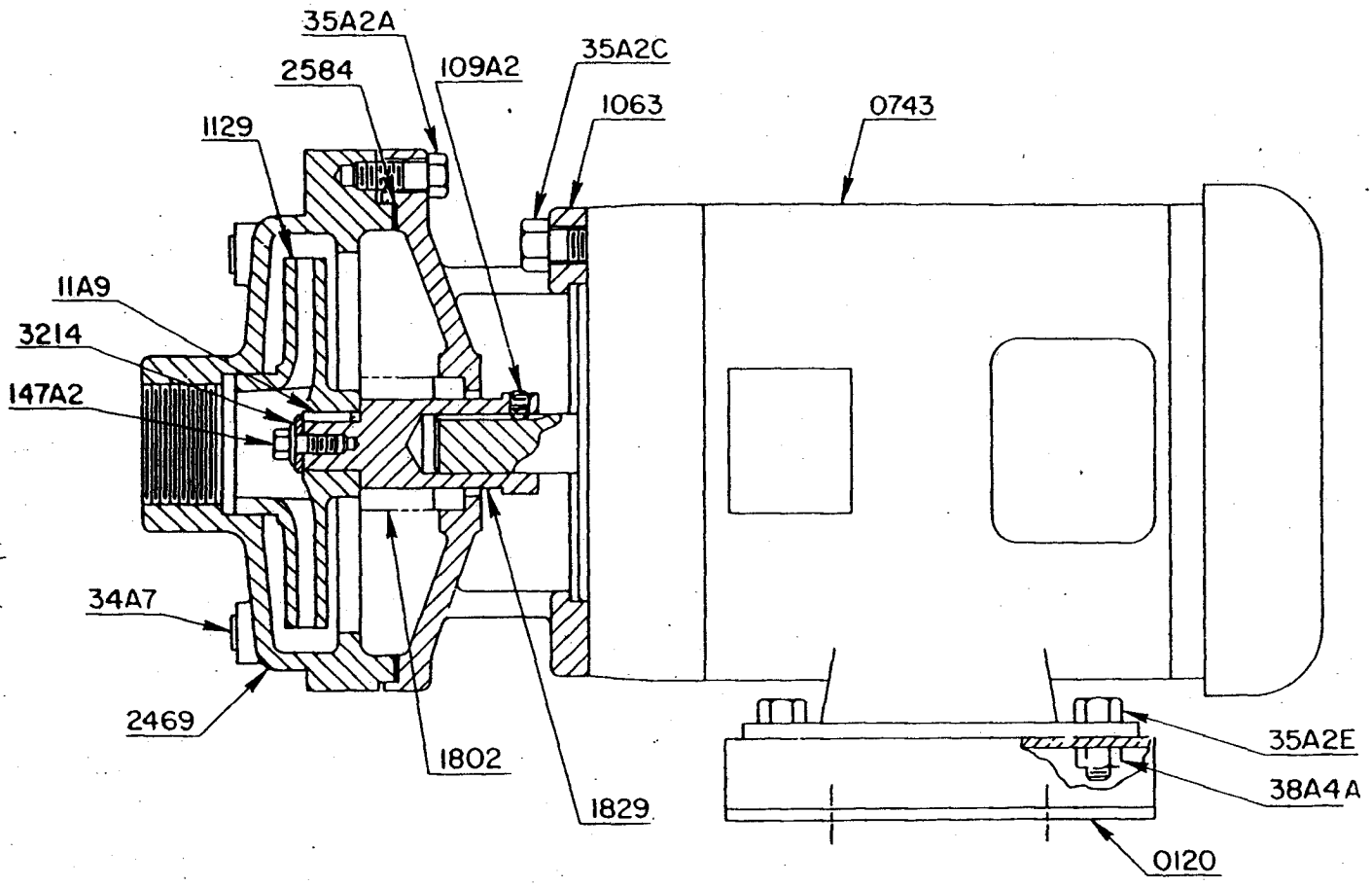
When contemplating operation at some viscosity other than that for which the pump was originally designed, the changed conditions should be referred to the nearest Ingersoll-Dresser Pumps Branch Office for recommendations.

SMP—1000 SERIES
CROSS-SECTION AND PARTS LIST



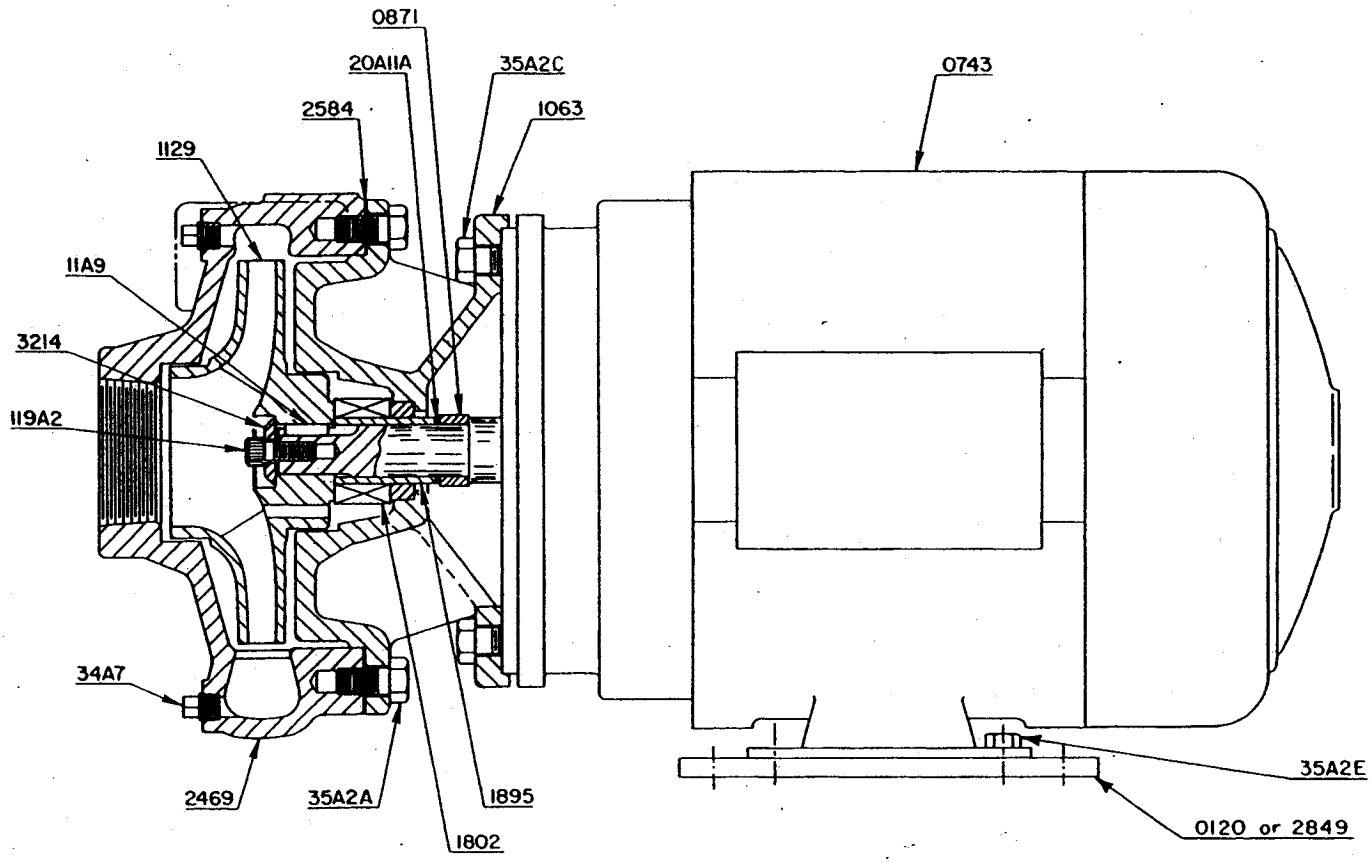
Part No.	Description
0210	Capscrew (Impeller)
0743	Motor
1063	Support Head
1129	Impeller
1295	Foot for Motor
1802	Seal
1829	Shaft
2469	Casing
2584	Gasket (Casing Flange)
3214	Impeller Washer
34A7	Pipe Plug
35A2A	Capscrew (Casing)
35A2C	Capscrew (Motor)
109A2	Hex. Soc. Set Screw

SMP—2000 SERIES
CROSS-SECTION AND PARTS LIST



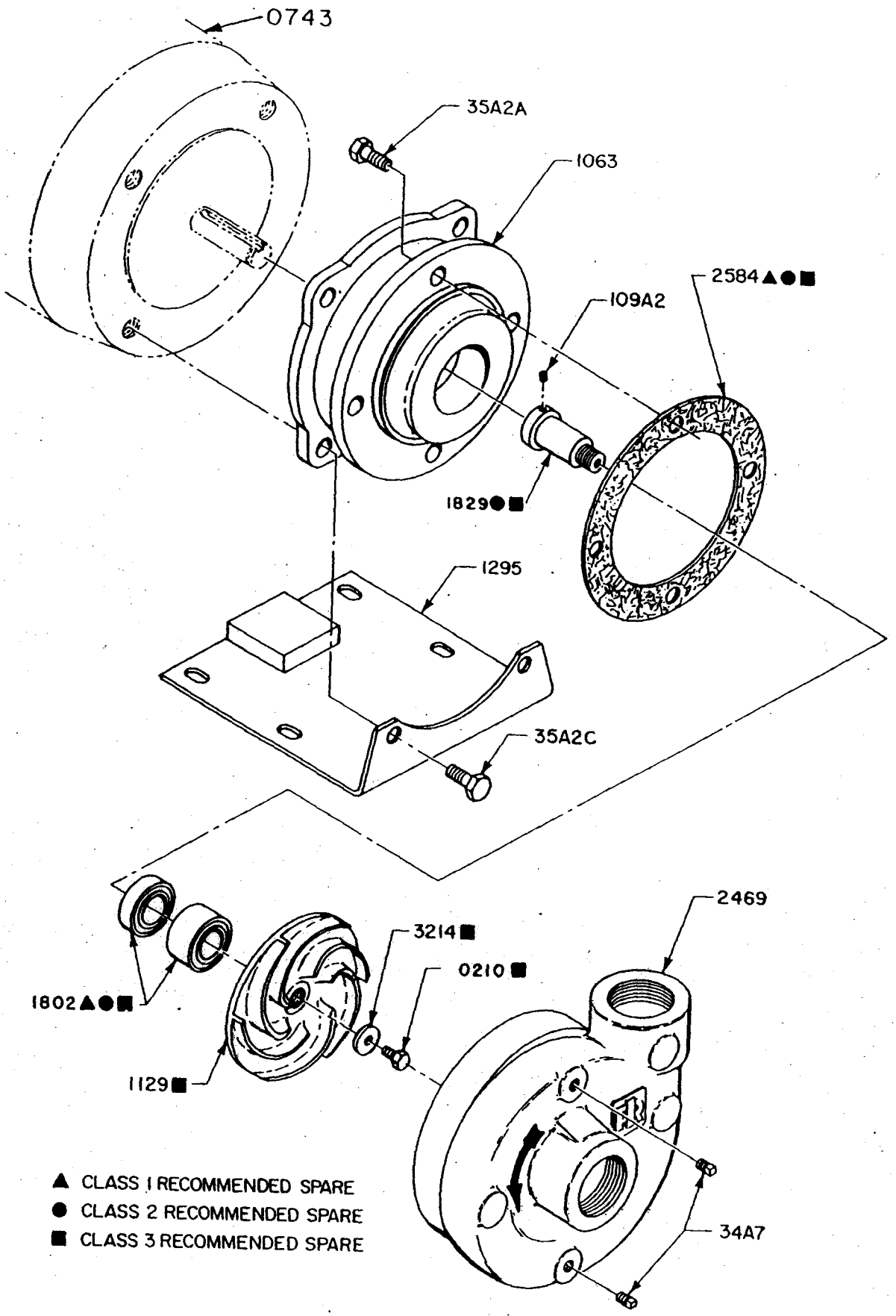
Part No.	Description
0743	Motor
1063	Support Head
1129	Impeller
2469	Casing
2584	Gasket (Casing Flange)
3214	Impeller Washer
0120	Bedplate
1802	Seal
11A9	Key (Motor Shaft)
34A7	Pipe Plug
35A2A	Capscrew (Casing)
35A2C	Capscrew (Motor)
35A2E	Capscrew (Bedplate)
38A4A	Hex. Nut
147A2	Capscrew (Shaft)
109A2	Pipe Plug
1829	Stub Shaft

SMP—3000 SERIES
CROSS-SECTION AND PARTS LIST

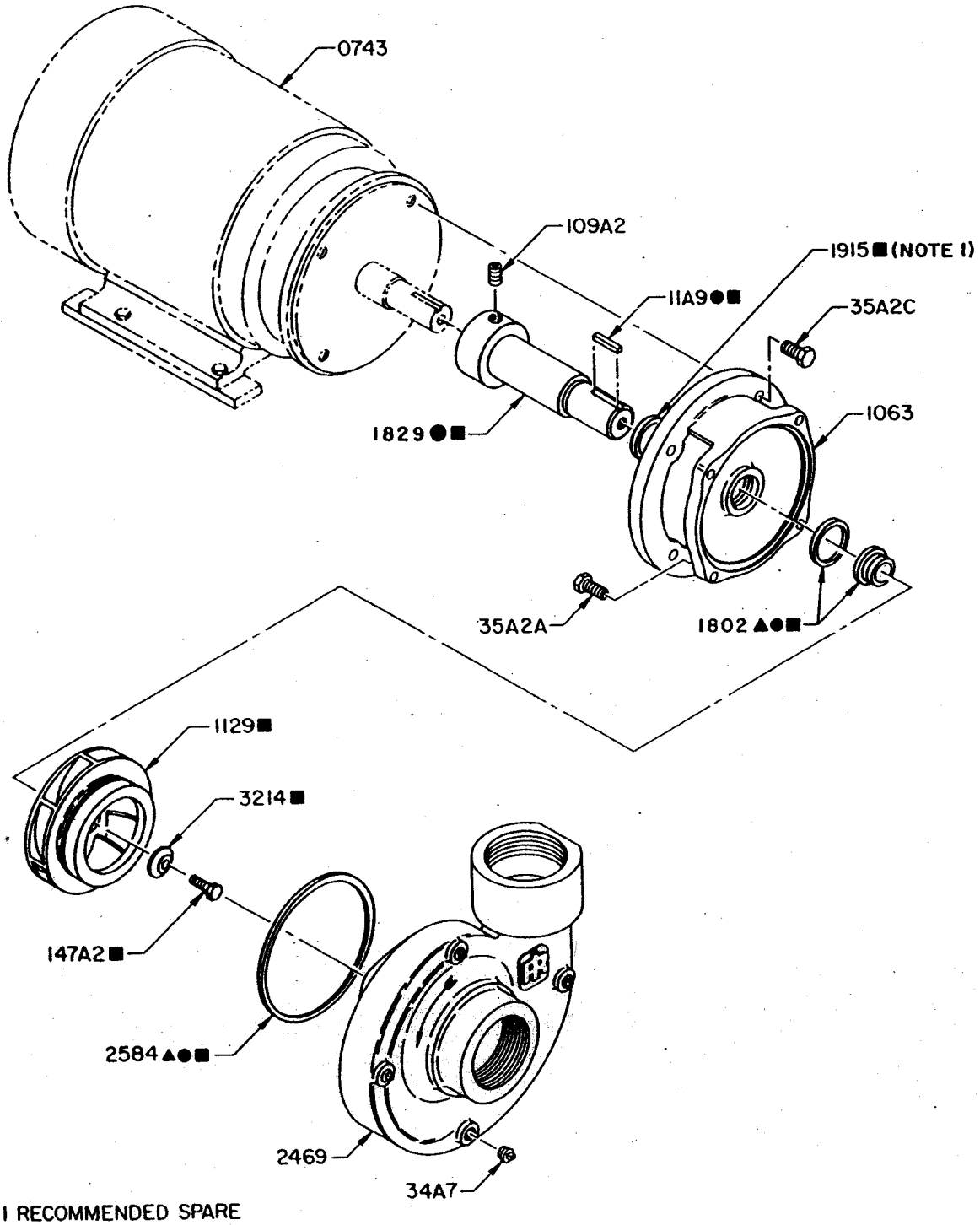


Part No.	Description
0743	Motor
0871	Flinger
1063	Support Head
1129	Impeller
1802	Seal
1895	Sleeve
2469	Casing
2584	Gasket (Casing Flange)
3214	Impeller Washer
0120	Motor Support
2849	Motor Support
11A92	Capscrew
11A9	Key (Motor Shaft)
20A11A	O-Ring (Sleeve)
34A7	Pipe Plug
35A2A	Capscrew (Casing)
35A2C	Capscrew (Motor)
35A2E	Capscrew (Motor Support)

SMP—1000 SERIES
EXPLODED PARTS VIEW

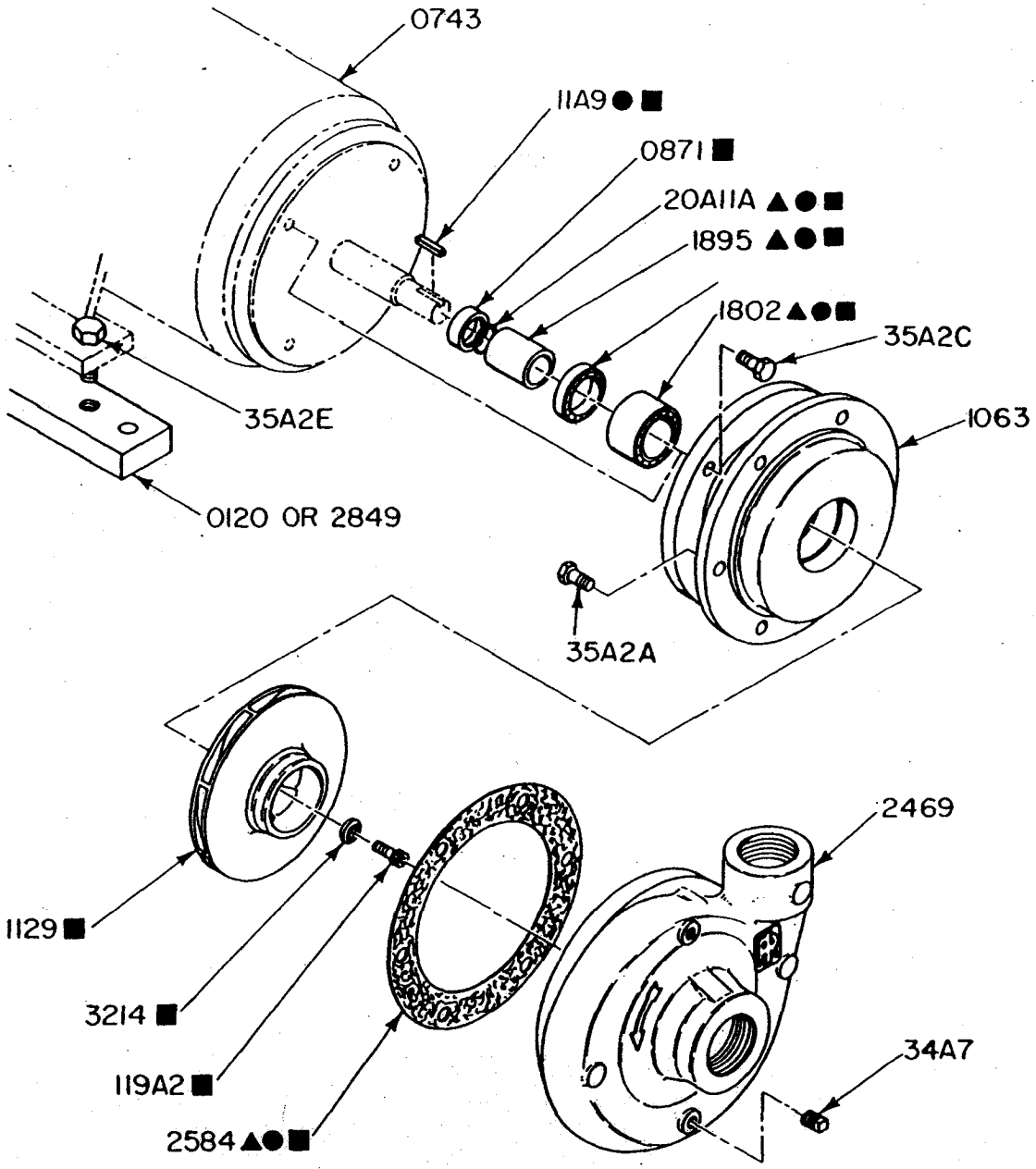


SMP—2000 SERIES
EXPLODED PARTS VIEW



▲ CLASS 1 RECOMMENDED SPARE
● CLASS 2 RECOMMENDED SPARE
■ CLASS 3 RECOMMENDED SPARE
NOTE 1 - WHEN FURNISHED

SMP—3000 SERIES
EXPLODED PARTS VIEW



▲ CLASS I RECOMMENDED SPARE
● CLASS 2 RECOMMENDED SPARE
■ CLASS 3 RECOMMENDED SPARE

RECOMMENDED SPARE PARTS LIST

PART NUMBER	DESCRIPTION	CLASS		
		1 Min.	2 Av.	3 Max.
2469	Casing			
2584	Gasket—Casing to Support Head	1	1	1
35A2A	Bolts—Casing to Support Head			
34A7	Pipe Plug—Casing			
1063	Support Head			
35A2C	Bolts—Support Head to Motor			
0743	Motor			
1295	Motor Foot			
0120	Baseplate			
2849	Motor Support			
35A2E	Bolt—Motor to Baseplate or Support			
1129	Impeller			1
11A9	Impeller Key		1	1
3214	Impeller Washer			1
0210	Impeller Bolt—1000 Series			1
147A2	Impeller Bolt—2000 Series			1
119A2	Impeller Capscrew—3000 Series			1
1829	Stub Shaft		1	1
109A2	Set Screw			
1915	Spacer—2000 Series-56C Frame Motors			
1895	Shaft Sleeve—3000 Series	1	1	1
0871	Flinger			1
20A11A	O-Ring	1	1	1
1802	Mechanical Seal	1	1	1

FOR ORDERING INSTRUCTIONS, SEE BACK COVER.

ORDERING INSTRUCTIONS

BY GIVING COMPLETE INFORMATION, YOU WILL ENABLE US TO FILL YOUR ORDER CORRECTLY AND AVOID UNNECESSARY DELAYS.

HOW TO ORDER REPLACEMENT PARTS

When ordering replacement parts, plase specify:

1. The SIZE & TYPE, MODEL and SERIAL NUMBER as stamped on the PUMP NAME PLATE. (The Size is the numerical prefix to the Type).
2. The FORM NUMBER of this booklet. (FORM CPK1113A.)
3. The QUANTITY.
4. The PART NUMBER and DESCRIPTION exactly as listed.

EXAMPLE

11/2 x 3 SMP Serial No. 0782-2001
Form CPK1113A
1 — 2469 Casing
1 — 1129 Impeller

HOW TO SELECT RECOMMENDED SPARES

Each Parts List shows the parts which are included in each of the following three classes of recommended spare:

CLASS I – MINIMUM – Suggested for Domestic Service when the pump is handling clean non-corrosive liquids and where interruptions in service are not important.

CLASS II – AVERAGE – Suggested for Domestic Service when the pump is handling abrasive or corrosive liquids and where some interruptions in continuity of service are not objectionable.

CLASS III – MAXIMUM – Suggested for Export Marine or Domestic Service where minimum loss of service is essential.

Our Sales Representative in your area will gladly review the class of spares best suited to meet your requirements.

When ordering recommended spares, please follow the procedure as outlined for ordering replacement parts.

We recommend use of original IDP replacement parts in the maintenance of your unit. Precise tolerances, metallurgy, manufacturing processes and heat treatment are important factors in the design of each component and the service it will provide. Failure of any component can possibly result in extensive damage to your unit. Warranty may be terminated based on the installation of non-OEM parts.

IDP Regional Entry Centers are designed to be responsive when replacement parts are needed quickly. Direct lines connecting our Parts Distribution Center, Distributors and Pump Repair Centers create a network able to respond almost instantly to your requests.

FASTRAQ (Fast Transactions/Responses/Answers/Quotations) can be accessed by our Order Entry Group or an IDP Distributor to give accurate, up-to-the-minute information on needed parts. In addition, FASTRAQ can provide quotes and place orders.

For repair parts service contact your nearest IDP pump sales office or Pump House distributor. They're in the Yellow Pages.

For the name, address and
phone number of your nearest authorized
Ingersoll-Dresser Pump distributor,
Call 1-800-728-7867

Ingersoll-Dresser Pumps
3900 COOK BOULEVARD • CHESAPEAKE, VA 23323-1626

Form Mem 1113A-050699-EN

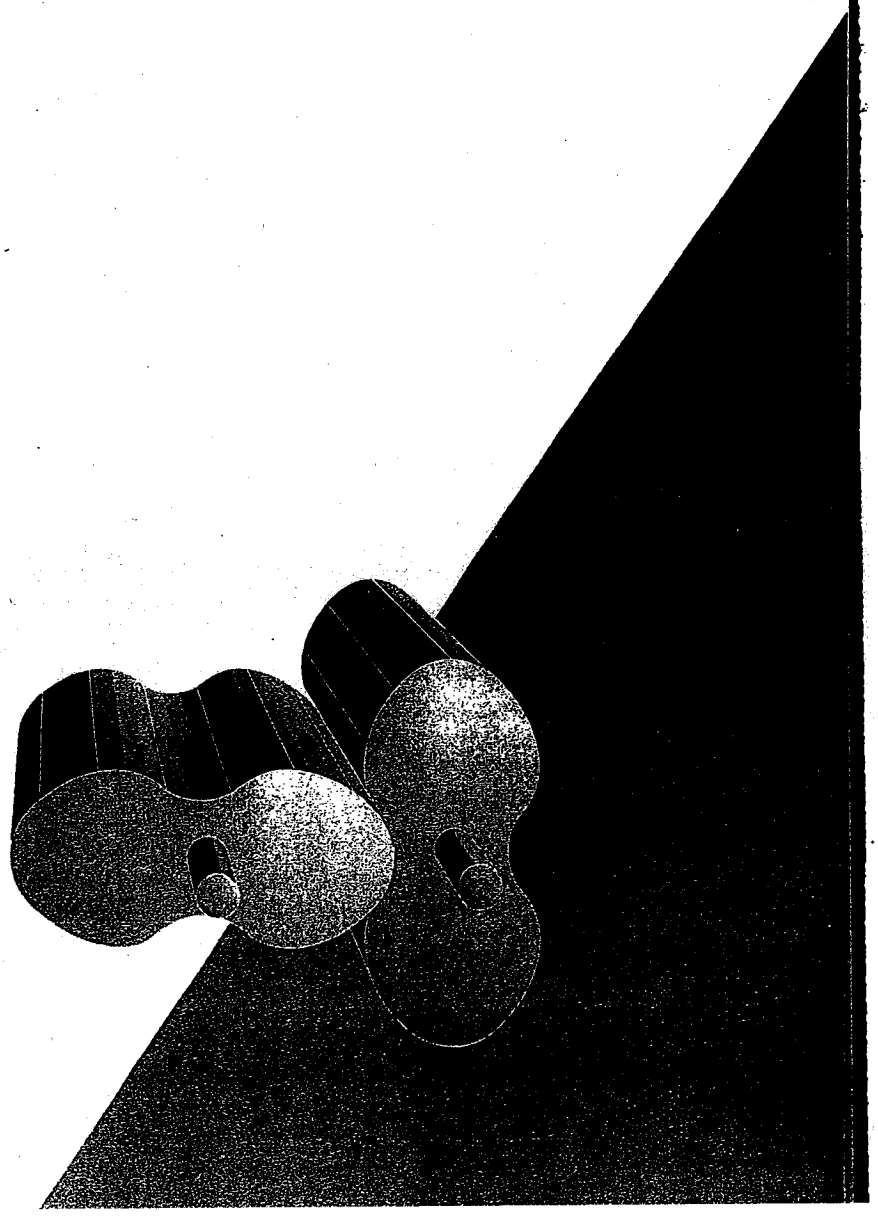
SERVICE MANUAL

Rotary Blower Package

Model: BB 53/3HP, Std. TEFC

Serial No 539/9102

Part No.: AN053B003YPR



IMPORTANT

Read entire service manual before operating unit or performing any maintenance.

Always shut off power to unit at main disconnect switch before attempting any maintenance. All system pressure should be discharged unless manual instructs otherwise.

Use only **Kaeser Compressors** approved replacement parts.

DANGER

Do not attempt solids flow through blower. Doing so can damage or cause failure of the blower.

This blower is intended for use with non-toxic, inert gases. Please contact **Kaeser Compressors** for use with toxic or flammable gases.

ATTENTION

Kaeser Compressor declines responsibility for any modification made to any **Kaeser Omega Blower** other than those made at the **Kaeser** factory or those made with prior written permission from **Kaeser Compressors**.

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KAESER COMPRESSORS

Table of Contents

KAESER COMPRESSORS

1. Technical Specification — KCI pn AN053B003YPR

1.1 Rotary Blower Package — BB53 / 3HP, Std TEFC

Air flow capacity, Based on Actual Inlet Conditions	49	ICFM
Air flow capacity, Based on Standard Inlet Conditions	49	SCFM
Rotary blower performance	2.2	BHP
Rotary blower speed	2182	RPM
Inlet pressure	14.7	Psig
Discharge pressure	20.7	Psig
Pressure difference	6.0	Psig
Temperature difference Δt	92	°F
Approximate weight	259	Lbf
Estimated noise level, free field (at one meter, without enclosure)	74	dB(A)
Estimated noise level, free field (at one meter, with enclosure)	56	dB(A)

1.2 Motor

Electric motor

Rated power	3	HP
Frame Size	NEMA	182T
Rated speed	3500	RPM
Enclosure	TEFC	
Service factor	1.15	

V-Belts

Description	(Qty of 2) SPZ 937 mm mm
Tension at Deflection Distance	1.9-2.1 lbf / belt at 0.19" deflection

1.3 Electrical Connection

Power supply	230 / 460V	3 Ph
Frequency	60	Hz
Maximum suggested main disconnect fuses (dual element or time delay)	15 / 6	A*
Supply cable cross-section (CU multicore)	14 / 14	AWG*
Full load rated current I_R	6.8 / 3.4	A

* see chapters 2.3 and 6.3

1.4 Lubricant Capacities

Drive end	4.5	Oz.
Gear end	5.1	Oz.

1.5 Recommended Lubricants

Use the following lubricants depending on the blower discharge temperature associated with the application.

Application Temperature	Recommended lubricant	ISO Viscosity Grade
Blower discharge up to 250 °F	SHELL Morlina 220 (mineral lubricant)	220
Blower discharge up to 250 °F	OMEGA SB-220 (synthetic lubricant)	220
Blower discharge up to 320 °F	OMEGA SB-320 (synthetic lubricant)	320

The rotary blower provided with the blower package is pre-filled at the factory with SHELL Morlina 220 mineral lubricant. The pre-filled lubricant should be drained out of the blower after 200 hours from its initial start-up.

Attention!

We strongly recommend using OMEGA SB synthetic lubricant, specially formulated for use with rotary blowers, when refilling the blower for lubricant changes at the specifed service intervals (See Section 9.2). Select an ISO Viscosity Grade based upon the blower discharge temperature associated with the application. Consult the factory for other grades of lubricant for special applications.

1.6 Designation

The nameplate of the rotary blower package is located on its frame.
(see chapter 10 for nameplate illustration).

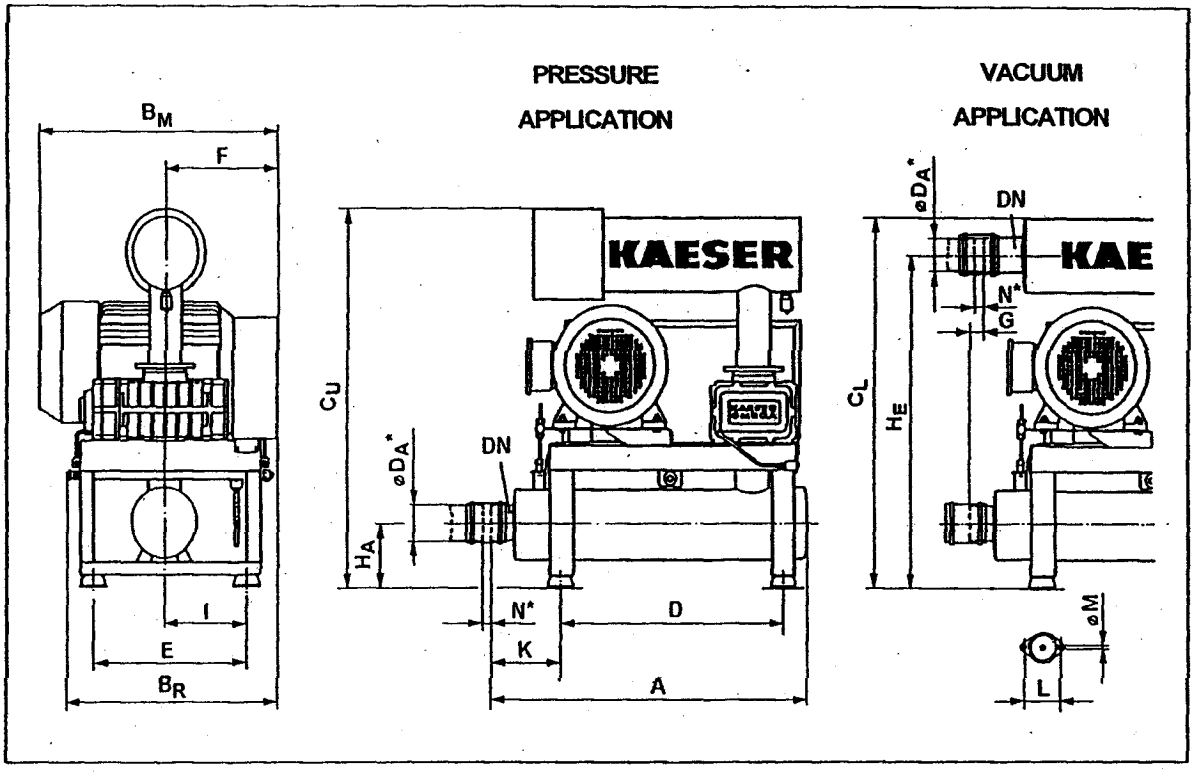
1.7 Installation Requirements

Minimum ambient temperature	40	°F
Maximum ambient temperature	105	°F

Install in a machine space or similar surroundings.

1.8 Dimensional Drawing

BB53



All dimensions are approximate and given in inches

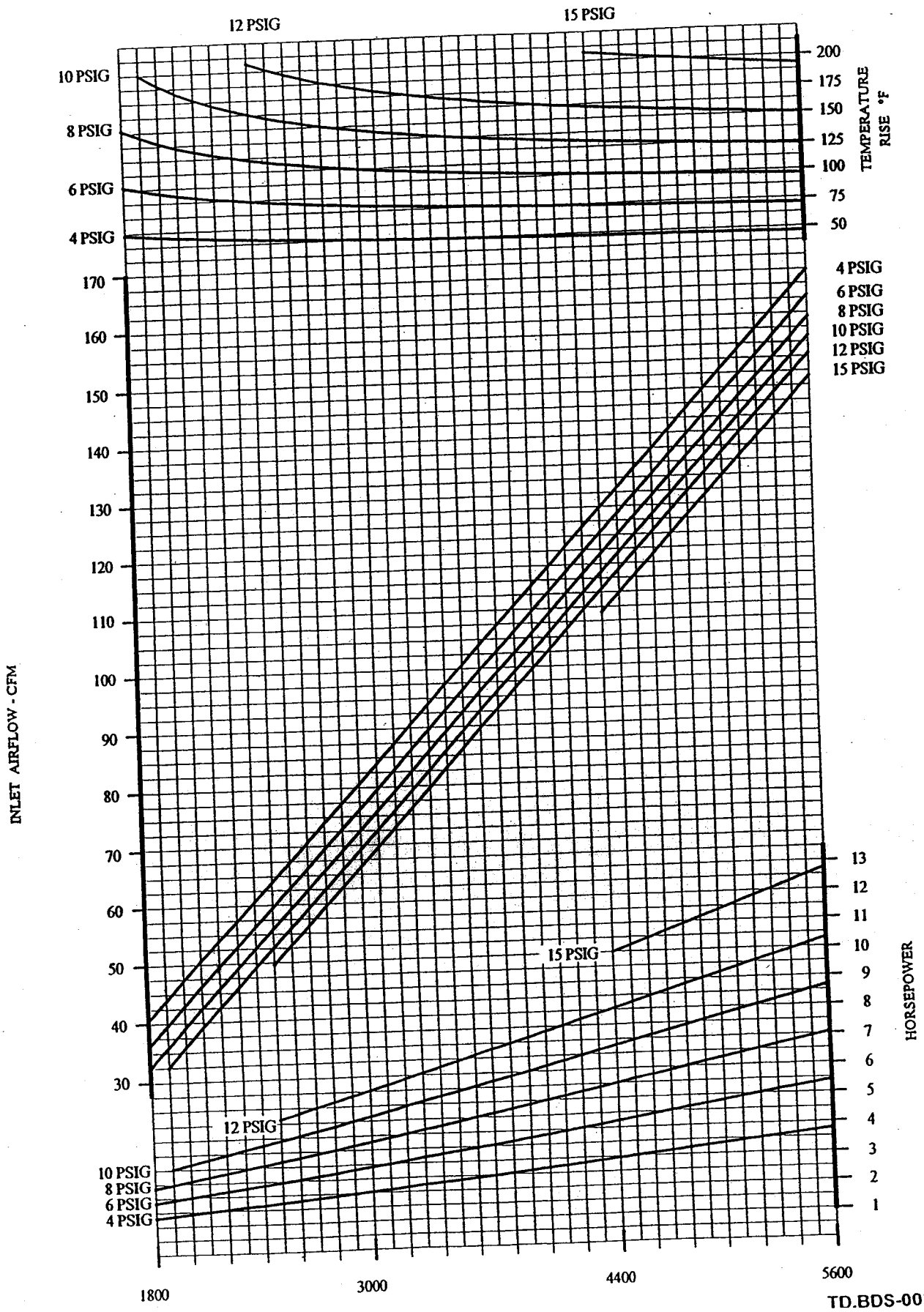
DN	A	B_M	B_R	C_U	C_L	D	E	F	G	H_A	H_E	I	K	L	M	D_A	N ±0.4
2	29.9	16.0	17.8	33.9	32.7	20.1	13.8	9.3	0.6	5.7	29.3	7.5	7.1	4.3	0.35	2.3	2

1.9 Performance Curves

KAESER COMPRESSORS

OMEGA 21

PRESSURE PERFORMANCE
14,7 PSIA and 68 °F



2. Safety Regulations

Read this service manual carefully and observe all cautionary references before putting the rotary blower package into operation and before carrying out any maintenance

2.1 Explanation of Symbols and References

This symbol is placed before all references to safety where danger to life and limb can occur during work. It is especially important that these instructions are observed and that extreme care is taken.
For their own protection inform all other users of these safety regulations. Observe general safety and accident prevention regulations as well as the safety instructions laid down herein.

Attention! **This symbol is placed at points where considerable attention should be paid to recommendations, instructions, references and correct sequences so that damage or destruction of the blower package and/or other equipment is prevented.**

This symbol identifies environmental protection measures.

☞ **This symbol indicates operations to be carried out by the service technician or the operator.**

● **This bullet indicates listings.**

2.2 Precautions

We recommend observation of the following precautions:

- No open flames and flying sparks at the place of installation.
- Ensure that sparks or high temperatures cannot cause fire or explosion during any necessary welding work on the blower package.
- Operating personnel must be instructed on the necessity of wearing ear muffs during operation of the blower package, especially during operation without the acoustic hood.
- Personnel should not linger for long periods in the direct vicinity of blower packages with damaging sound levels.
- Rotary blower packages may not be used for explosive, toxic, corrosive or damaging gases.
- Because of the high temperatures (up to 300 °F) do not touch the air pipes during blower package operation. Wait until the blower has cooled down and pressure has vented before attempting any repairs to the pipework.
- Use only the lubricants recommended by the manufacturer.

2.3 General References

Only trained or specialised personnel may work on power driven systems.

Before work is carried out on electrical systems, carry out the fol lowing precautions in the sequence shown:

Lock the main disconnect in the "OFF" position in accordance with applicable lock out/tag out procedures to ensure the blower package does not restart (as per OSHA CFR 29 §1910.147).

Lock the air discharge valve in the "CLOSED" position and vent all air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures (as per OSHA CFR 29 §1910.147).

Attention! **The warranty is invalid if any modifications are carried out without previous consultation and the consent of KAESER COMPRESSORS.**

2.4 Spare Parts

Safe and reliable operation of the rotary blower package is only guaranteed with KAESER original spare parts.

3. General

3.1 Correct Use

The rotary blower package is intended solely for the transport of oil-free air or any inert gas without liquid or solids in conformity with the technical specification (see section 1.1). Any other use is considered incorrect. Do not use this blower package for any combustible gas applications. For special gas applications contact KAESER COMPRESSORS, INC.

The manufacturer cannot accept liability for any damage caused by incorrect use. The user alone is liable for any risks incurred. Correct use also means compliance with installation, removal, commissioning, operational and maintenance instructions laid down by the manufacturer.

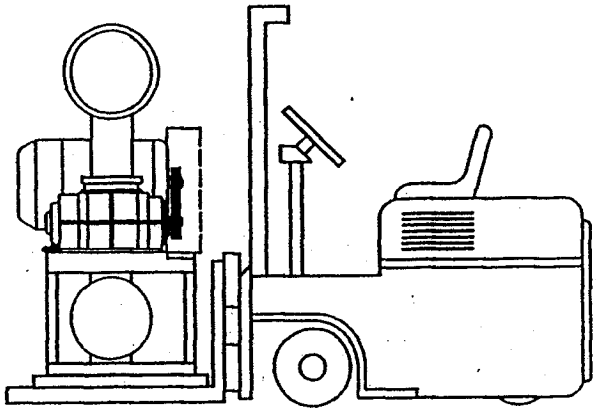
This service manual is intended for operating, maintenance and supervisory personnel use only.

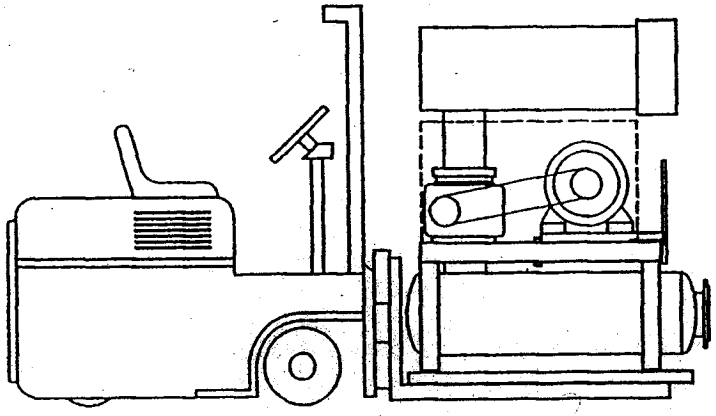
3.2 Copyright

4. Transport

4.1 Transport Instructions

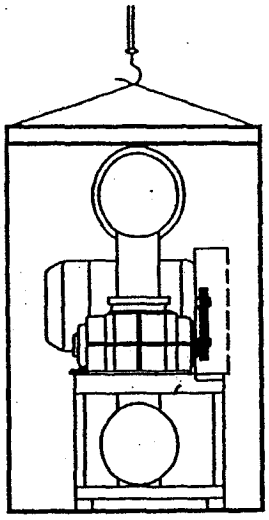
Attention! **To avoid damage to components of the rotary blower package we recommend the use of a fork lift truck, lift truck or a sling for transport.**





Attention! **When transporting the blower package using a crane hook a suitable sisal or steel sling must be used (VBG 9a).**

If lifting the blower package with a sling or rope it should be fastened to the frame and padded if necessary.



No side forces should act upon the blower package when transporting with a sling. Always use a spreader !

Avoid sudden, sharp vertical movements when lifting, lowering and transporting the rotary blower package.

4.2 Packaging

A decisive factor concerning the type of packaging is the transport route.
The packaging conforms to the packaging regulations laid down by the German Federal Association of Wood, Pallet and Export Packaging (HPE) and by the Association of German Mechanical Engineering Institutes (VDMA), if not otherwise contractually agreed.

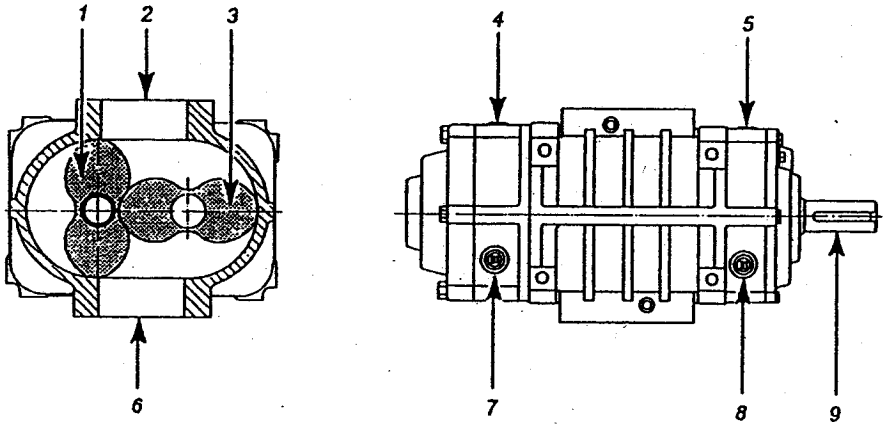
5. Construction and Principles of Operation

5.1 Construction

Kaeser rotary blower packages are delivered with the blower in the "horizontal configuration"

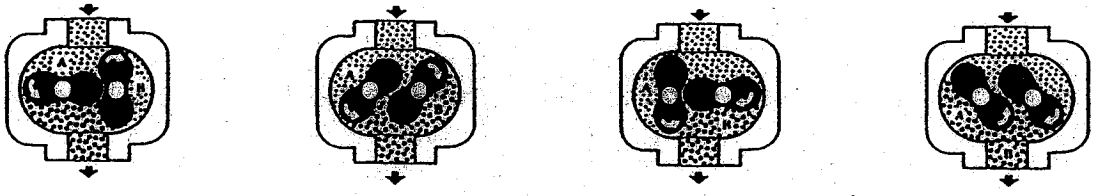
Horizontal configuration

- The drive shaft (9) is located at the left-hand rotor
- The following diagram shows the positions of the oil level sight glasses (7) and (8) and the oil filler plugs (4) and (5)



1 Male rotor
2 Inlet port
3 Female rotor
4 Oil filler plug, gear end
5 Oil filler plug, drive end
6 Discharge port
7 Oil level sight glass, gear end
8 Oil level sight glass, drive end
9 Drive shaft

5.2 Principles of Compression



The KAESER Omega positive displacement rotary blower has two uniquely designed figure-eight shaped rotors that rotate in opposite directions. As the rotor passes the blower inlet, it traps a quantity of air and carries it around the housing to the discharge. The relative position of the rotors is fixed by the use of timing gears which maintain the critical internal clearances essential for high volumetric efficiencies. Rotor lubrication is not necessary since the rotors do not touch thus keeping the discharge air free of oil.

5.2 Principles of Operation

The rotary blower is belt driven from an electric motor.
The electric motor and the blower are mounted on a common base frame.
The flow medium is drawn into the blower via an inlet silencer in which an inlet filter is integrated for pressure applications (an in-line inlet filter is available as an option for vacuum applications).
The air flows in a vertical direction in the discharge silencer.
The compressed air is discharged at the connecting flange of the discharge silencer.

6. Installation

6.1 Installation Requirements

The rotary blower package must be installed in a space of sufficient size allowing free access from all sides for maintenance and repair.

Sufficient air ventilation and exhaust conditions must be provided.

A special foundation or base is not required for installation.

Safe and reliable operation of the blower package is guaranteed only when the temperature limits (see chapter 1. 8) are complied with.

6.2 Compressed Air Connection

The blower package is delivered ready for operation up to and including the compressed air discharge connection.

The discharge connection downstream to the pipework or user should be made via a flexible connecting sleeve, preferably a high temperature resistant rubber sleeve.

It is especially important that necessary safety devices, a check plate and operational measuring and control devices are provided.

If the air flows into a system which remains pressurized after switching off the blower package, an blow-off valve or similar device must be provided.

To ensure safe and reliable operation of the blower package it is recommended that at least the following parameters are monitored and interlocked with the drive:

- Discharge pressure or pressure difference Δp
- Discharge temperature
- Electrical current drawn

6.3 Electrical Connection

Before servicing the blower package dot the following:

- **with applicable lockout/tagout procedures to ensure the blower does not restart.**
- **Lock the air discharge in the closed position and vent all compressed air trapped between the blower package and air discharge valve in accordance with applicable lockout/tagout procedures.**

For proper sizing of wires and fuses refer to the table in chapter 1.3.

Please note that conductors, fuses and procedure are Kaeser's recommendations and do not supersede any other applicable codes.

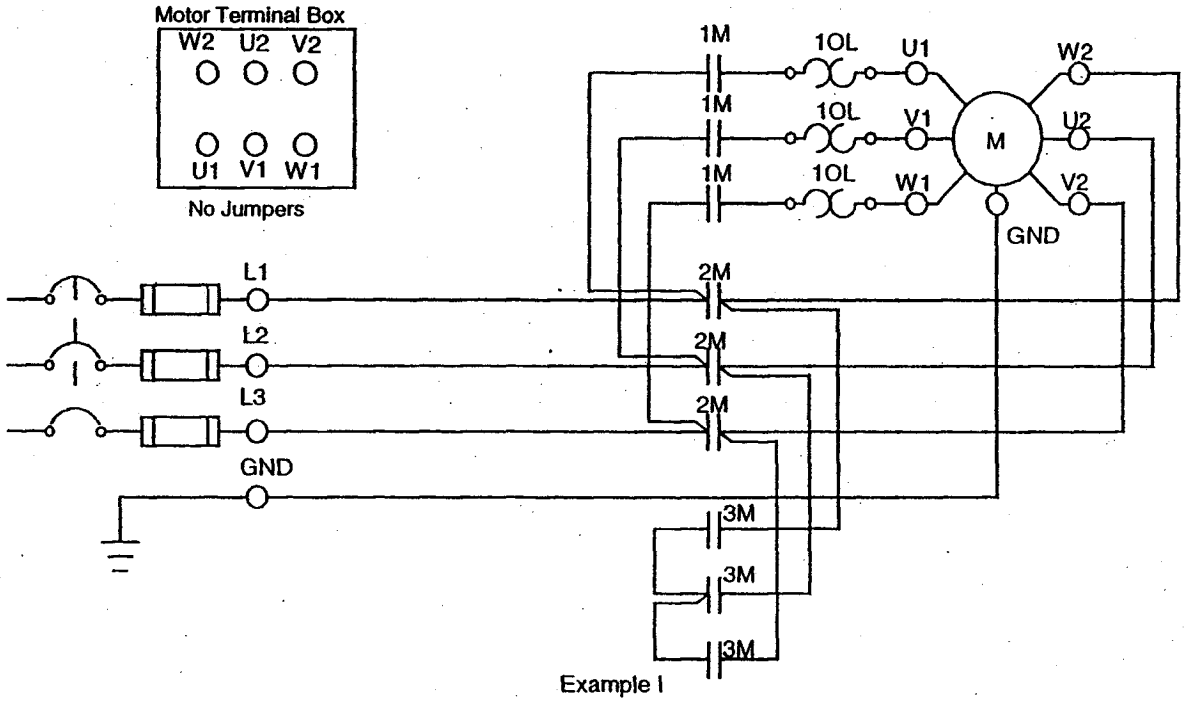
6.4 Lubricant Oil Filling

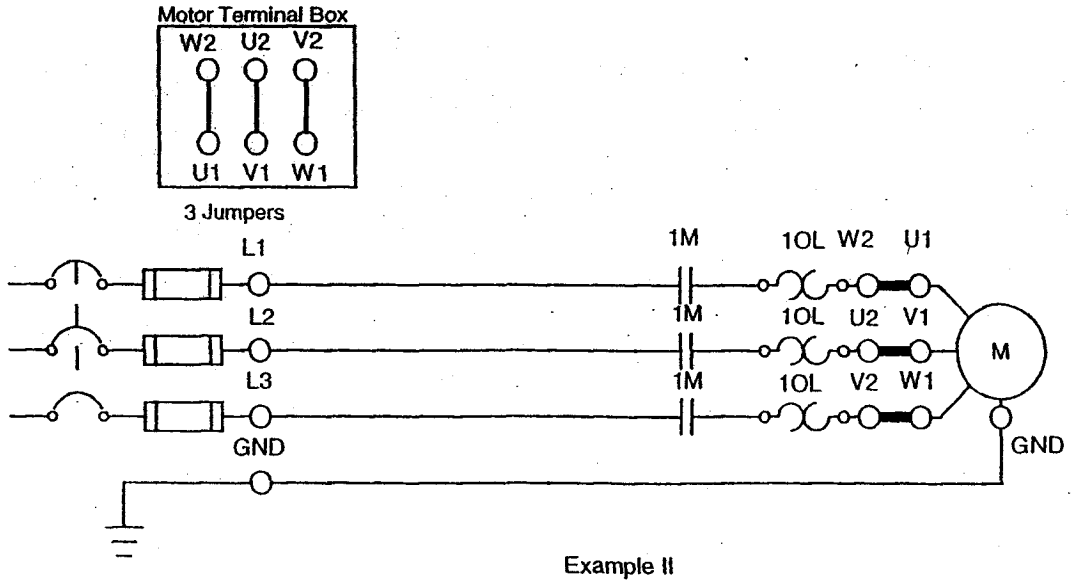
Attention! **The rotary blower package is delivered with a full charge of lubricating oil.**

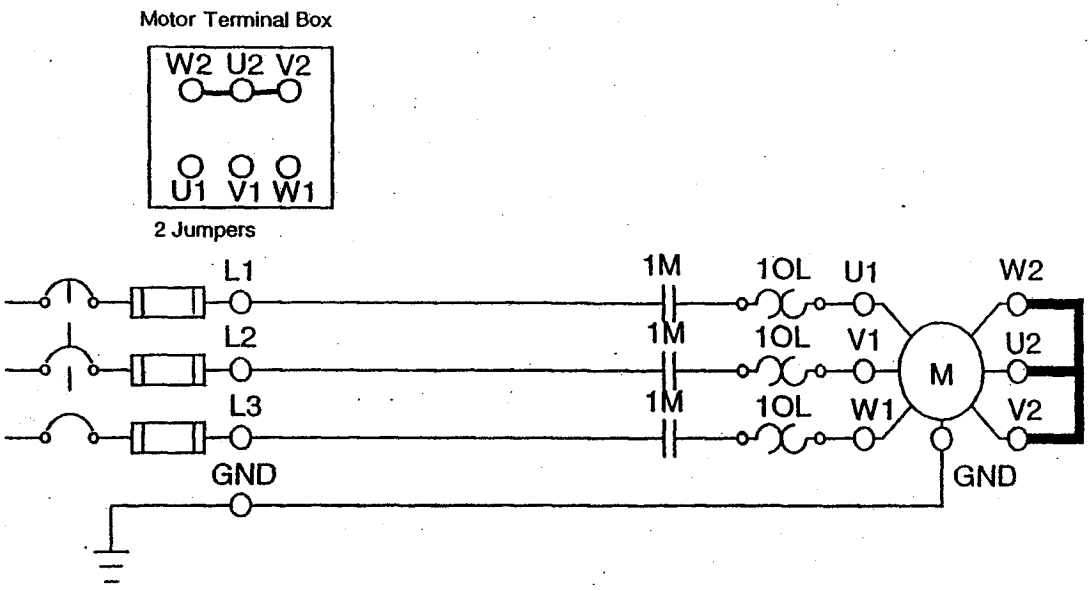
Type of oil used: see chapter 1, sections 4 and 5.

6.5 Motor Wiring Diagrams

The following are examples of how the motor for the blower package is to be wired. Check the nameplate on the motor in section 6.6 to see which example of wiring should be used.







Example III

6.6 Examples of Motor Nameplates

6.6.1 230 V wye delta and 230/460 V direct on line starting

Motor nameplate	
230/460	Δ/Y

Operation	Example wiring
230 V wye delta start	I
230 V DOL (direct on line) start	II
460 V DOL start	III

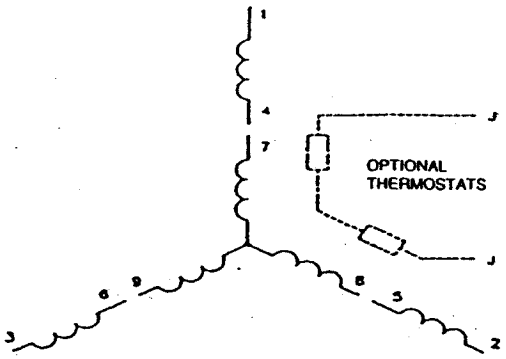
6.6.2 460 V wye delta and direct on line starting

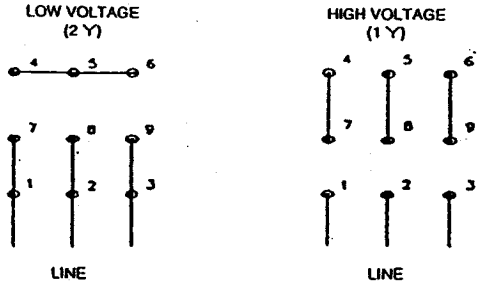
Motor nameplate	
460	Δ

Operation	Example wiring
460 V wye delta start	I
460 V DOL (direct on line) start	II

Installation

3 Phase, 60 Hz, Dual (230/460v) Voltage, Nine (9) Lead Motor, Wye Connection

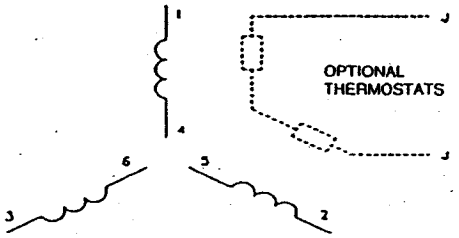


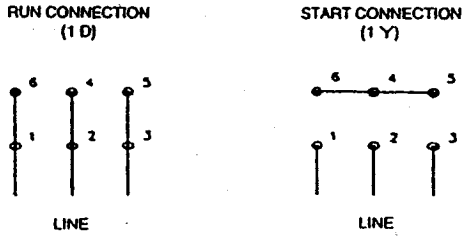


NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

3 Phase, 60 Hz, Single (460v) Voltage, Six (6) Lead Motor, Wye Start - Delta Run

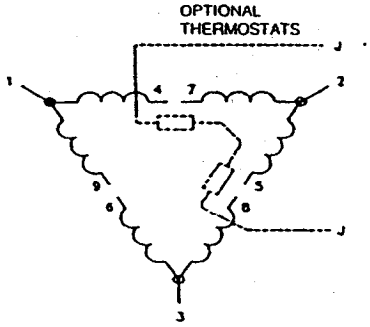


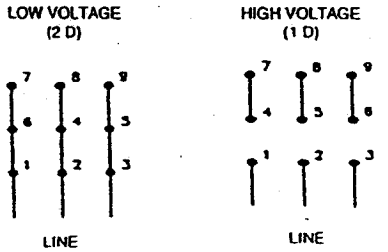


NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

3 Phase, 60 Hz, Dual (230/460v) Voltage, Nine (9) Lead Motor, Delta Connection





NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

7. Putting into Operation

7.1 Points to be Observed

Every rotary blower package is given a test run at the factory and carefully checked before shipment. The test run confirms that the blower package conforms to the specification data and runs satisfactorily. However, it is recommended that the blower package is inspected for damage that could have occurred during transport. The blower package should be carefully observed during the first hours of operation to determine any malfunction that could occur.

The user is responsible for the installation of the complete blower package.

- Before putting into operation check the correct sequence of the recommended safety and monitoring devices and the necessary operational measuring and control devices for the processing technology used.
- Check the valves and controls for correct installation.
- Remove the blanking caps fitted during installation.

7.2 Starting Precautions

ANY NON-OBSERVANCE OF THESE OR OTHER PRECAUTIONARY REFERENCES (WARNING, ATTENTION) COULD LEAD TO AN ACCIDENT CAUSING PERSONNAL INJURY OR DAMAGE TO EQUIPMENT.

☞ Remove all packaging materials, tools and transport safety devices from the blower package.

- It is expected that the user employs safe working methods and complies with all valid local operating and safety regulations when operating the blower package.
- It is the responsibility of the user to ensure that the blower package is constantly kept in a state of operational safety.
- Do not operate the blower package in spaces in which high dust pollution, toxic or inflammable vapors and gases can form.
- Do not connect the blower package to a different power supply than that stated on the nameplate.
- Install the blower package in a frost-free space where the ambient temperature conditions are met.

☞ Check the drive shaft of the blower for ease of rotation by turning with the hand.

☞ Check the tension of the belt drive.

Before servicing the blower carry out the following:
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

7.3 Direction of Rotation Check

Danger from rotating parts

- The rotary blower must rotate in the correct direction.
- The correct direction of rotation is counter-clockwise when looking at the end of the shaft.
- An arrow indicating the direction of rotation is located on the belt guard and on the blower.

☞ If a KAESER CONTROL is provided check the direction of rotation by turning the control switch to "I" and then immediately back to "O" again and observing the direction of rotation.

☞ If the direction of rotation is incorrect, the phase sequence in the power supply must be changed.

Attention! **If the blower block rotates in the wrong direction a reversal of the direction of flow and an evacuation of the discharge pipework occurs. Always check the direction of rotation with the discharge line disconnected because the blower block could be damaged or destroyed if foreign bodies are sucked in or a high vacuum is generated.**

8. Operation

8.1 Starting and Stopping the Blower Package

Observe the safety regulations when putting the blower package into operation.

The starting and stopping procedure depends largely on the application at hand, together with the control devices fitted.

Always start with the blower stationary. If back pressure is apparent in the pipework system then suitable measures ensuring off-load starting must be taken.

If the blower package is operated via a two-speed motor the changeover from high to low speed must be delayed, i.e. the speed must have reduced to the lower speed or the blower must have stopped rotating before the motor is started again at the lower speed.

The motor can be switched directly to the higher speed.

Attention! **Do not switch the blower package on and off with the mains isolating switch. Always switch the blower package on and off with the control switch.**

8.2 Action to be taken during a Malfunction

Attention! **General safety regulations (see chapter 2) and the corresponding local safety regulations must be observed during trouble-shooting**

Restarting after elimination of a malfunction:

See chapter 7 "Putting into Operation"

Explanation of the symbols used in the following sections:

⊗1 - Have checked by a specialist.

⊗2 - Refer to KAESER customer service.

8.2.1 Abnormal running noises

Possible fault	Remedy
Backlash of the gears too large.	Check the backlash. If it is > 0.004" replace the timing gears; ⊗1 or ⊗2.
Bearing clearance is too large.	Measure the clearance. Replace the bearing if necessary; ⊗1 or ⊗2.
Rotors out of time.	Compare the conditions under use concerning pressure difference and speed with the conditions at delivery on nameplate.

KAESER COMPRESSORS

8.2.2 Excessive blower temperature

Possible fault	Remedy
Operation with excessive pressure difference.	Check the pressure difference and correct if necessary.
Contamination of the inlet filter causing degradation of volumetric efficiency.	Clean inlet filter.
Rotor clearance too large.	Measure the clearance between the rotors and check with the manufacturer. Rotor replacement could be necessary.

8.2.3 Oil leaking into the air chamber

Possible fault	Remedy
Oil level too high.	Drain the oil until the level is in the middle of the oil level sight glass. Clean out the air chamber with cleanser.

8.2.4 Low inlet volume flow

Possible fault	Remedy
Excessive rotor clearance caused by wear, especially by heavily contaminated flow medium.	Measure the clearance between the rotors and check with the manufactrer. Rotor replacement could be necessary; ⊗1 or ⊗2.
Inlet flow resistance too high.	Clean the inlet filter.

9. Maintenance

9.1 Precautions to be Observed during all Maintenance and Servicing

Work on power driven equipment may only be carried out by trained or specialized personnel.

Before carrying out any maintenance switch off the blower and lock out the mains isolating switch/electrical disconnect.
Isolate and depressurize the blower package and attached piping to zero psig.

Ensure that no personnel are working on the blower package before restoring power.

9.2 Regular Maintenance

Period	Work to be done	see chapter, section
2 and 24 hours after initial start-up	check the tension of the drive belts	9.3
50 hours after initial start-up	check all electrical connections for tightness and tighten, if necessary	9.1
200 hours after initial start-up	change the lubricating oil	9.6
monthly	check the lubricating oil level	9.6
500 hours	check the tension of the drive belts	9.3
2000 hours or at least annually*	clean or change the air filter	
1500 - 2500 hours*	change the lubricating oil (mineral)	9.6
6000 - 8000 hours*	change the lubricating oil (KAESER Omega synthetic)	9.6
annually	check all electrical connections for tightness and tighten, if necessary	9.1
annually	check the safety valve	

* The maintenance period can vary depending on the cut-in frequency and environmental conditions. The oil should be changed at least once annually, even if the blower was not in operation.

We highly recommend that a record is kept of maintenance work done (see chapter 11, sect. 1)

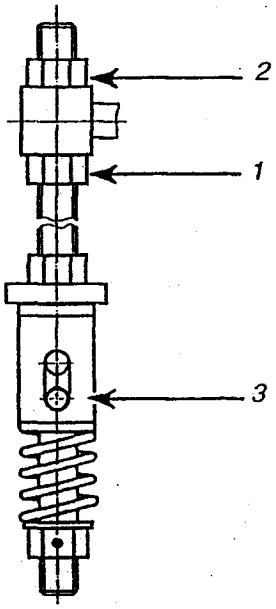
9.3 Checking the Tension of the Drive Belts

☞ Switch off the blower package (see chapter 8, sect. 1).

Before servicing the blower carry out the following:
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

Check the tension of the drive belts after the first 2 and 24 hours and then every 500 hours of operation.



1 Hex nut
2 Hex nut
3 Marking pin

The tensioning device automatically adjusts the belt tension over a certain range with the aid of a compression spring.

If the drive belts have stretched to the extent that the marking pin (3) is located at the lower end of the indicating slot the belt tension must be re-adjusted.

Proceed as follows:

☞ Loosen the hex nut (1).

☞ Tighten the belts with the hex nut (2) until the marking pin (3) is located at the top end of the indicating slot again.

☞ Tighten the hex nut (1) again.

9.4 Changing the Drive Belts

☞ Switch off the blower package (see chapter 8.1).

⚠ **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

☞ Remove the belt guard complete.

☞ Turn the hexagonal nut (2, see chapter 9.3) of the tensioning device upwards.

☞ Turn the hexagonal nut (2, see chapter 9.3) of the tensioning device clockwise until the drive belts are loose.

☞ Take off the drive belts.

☞ Lay the new drive belts over the motor and blower pulleys without straining them.

☞ Set the drive belt tension (see chapter 9.3).

☞ Mount the belt guard.

☞ Check the belt tension after two hours and then again after 24 hours of operation as experience shows that the belts stretch mostly during this period.

Attention! **It is essential that the drive belts are of precisely the same length in each set and absolutely impervious to oil. For this reason, we recommend that only original KAESER drive belts are used.**

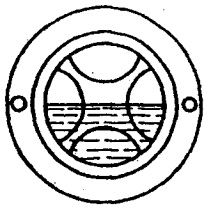
9.5 Lubricating Oil Level Check and Top-Off

Check the lubricating oil level monthly at the gear end and drive end with the blower package switched off. The oil level should never fall below the middle of the oil level sight glass. The oil level at the sight glass changes during operation because of the rotating parts. For this reason the check the oil level only when the blower package is shut down.

Attention! **If the oil level has fallen to 1/8" below the middle of the oil level sight glass, the blower must be topped off according to the instructions in the oil recommendations.**
Never top off the blower above the middle of the oil level sight glass otherwise oil could be forced into the vent chamber.

☞ Switch off the blower package (see chapter 8.1).

Attention! **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.
Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.



Lubricating oil level at middle of oil level sight glass

☞ Top off with lubricating oil via the "red" oil filler plugs on the gear and drive ends of the block until the middle of the oil level sight glass is reached. (see chapter 1.5).

Attention! **The oil chambers of the gear and drive ends are not connected to each other.**

9.6 Lubricating Oil Change

Attention! **Carry out the first lubricating oil change after the first 200 hours of service.**

See chapter 9.2 for recommended time interval for oil change.

☞ Switch off the blower package (see chapter 8.1).

Attention! **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

Carry out the oil change with the blower block in a warm state (approximately 131 °F).

Collect the used oil in a suitable container and dispose of according to Federal and local environmental regulations!

☞ Drain the oil via the "red" marked oil drain plugs on the gear and drive ends.
Fill up with new lubricating oil to the middle of the oil level sight glass via the "red" marked oil filler plugs on the gear and drive ends. (see chapter 9.5).
Use only the lubricating oil detailed in the oil recommendations (see chapter 1.5).

9.7 Cleaning the Blower Package

☞ Regularly clean the surfaces of the blower package and drive motor and keep free of dirt and contamination.

Attention! **Layers of dirt inhibit heat dissipation. Damage may occur through overheating.**

10. Spare Parts and After Sales Service

Nameplate:

KAESER COMPRESSORS	Fredericksburg, VA 22404 Tel. (540) 898-5500	
Model		Part-No.
Year		Serial-No.
psig	cfm	Voltage
Hz/RPM		FLA
Phase	HP	Scheme

Important:

☞ Enter the data from the nameplate found on the frame of the blower package into the nameplate illustrated above.

Please quote the following information for all inquiries and orders for spare parts:

Rotary blower package, model: .....

Serial No.: .....

Year of Manufacture: .....

Attention! **Use only KAESER original spare parts.**

11. Appendix

11.1 Maintenance Schedule

Serial number of the rotary blower package:

Date	Description of work	Service hours	Signature

12. Standard Accessories

12.1 Relief Valve

Kaeser provides a spring loaded relief valve with each Omega-paK™ blower package. The intended sole purpose of this relief valve is to protect the blower from inadvertent system over-pressurization. It is strongly recommended that all blower systems make use of a relief valve as an added measure of safety above and beyond other methods already being utilized (ie. high pressure and temperature switches, etc). Failure to do so can bear grievously dangerous consequences including serious equipment damage, personal injury or death.

Prior to shipment, each valve is 100% tested & inspected for blow-off set point, blowdown and leakage. All adjustments are factory sealed to prevent tampering or disassembly. Resetting of the valve setpoint or repair work should be performed by qualified repair personnel at facilities holding National Board valve repair stamps. Any attempt to adjust, repair or modify the valve by non-qualified or non-authorized persons voids the product warranty and poses considerable risk of danger.

The relief valve is shipped disconnected from the blower package. The following information is being provided as an installation guide to facilitate trouble-free service.

- Install the relief valve into the system piping (downstream of the blower for pressure, uptstream of the blower for vacuum).
- The valve should be placed as close as possible to the end of the rubber compensator sleeve attached to the discharge silencer (for pressure) or the inlet silencer (for vacuum).
- Sources of additional pressure drops (ie. check valves, elbows, reducers, tees, etc) should NOT be installed between the relief valve and the blower.
- Changing the setting of the valve is not permitted and voids any consideration for warranty liability.
- **IMPORTANT:**
  For proper operation of vacuum relief valves, the female threaded port is the valve inlet and this port must be connected to the vacuum source. Conversely, for all pressure relief valves, the male threaded port is the inlet and must be connected to the pressure source.

Instruction **Manual**

Electronic Metering Pumps

Carefully read and understand all precautions before installing or servicing any metering pump.

Please record the following data:

(Information on Pump Box and Pump Data Plate)

Pump Model Number: _____

Pump Serial Number: _____

Installation Date: _____

Installation Location: _____

When ordering replacement parts for your LMI Metering Pump or accessory, please include the complete model number and serial number of your unit.

LMI
MILTON ROY
A Sundstrand Company

8 Post Office Square • Acton, MA 01720 USA
TEL: (978) 263-9800 • FAX: (978) 264-9172
http://www.lmipumps.com

Printed in USA
All Prices FOB Acton, MA - Subject to change without notice

Replaces same of Rev. J 12/96
1615 Rev. K 5/99

1.0 Introduction

LMI is the world's most versatile manufacturer of economical and efficient metering pumps. This manual addresses the installation, maintenance and troubleshooting procedures for manually and externally controlled pumps. LMI has a worldwide network of stocking representatives and authorized repair centers to give you prompt and efficient service.

Please review this manual carefully. Pay particular attention to warnings and precautions. Always follow good safety procedures, including the use of proper clothing, eye and face protection.

This manual is for Series A, B, C, E, J5, and P pumps.

1.1 Spare Parts

LMI recommends replacing the elastomeric components of the pump on an annual basis. RPM Pro Pacs™ and spare part kits are available from your local LMI Master Stocking Distributor.

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 65 ACTON, MA

POSTAGE WILL BE PAID BY ADDRESSEE

LMI
LIQUID METRONICS DIVISION
MILTON ROY

LIQUID METRONICS DIVISION, MILTON ROY
8 POST OFFICE SQUARE
ACTON, MA 01720-9848 U.S.A.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

WARRANTY REGISTRATION INFORMATION

Register our warranty as follows:

Model No. _____
Serial No. _____
Installation Date _____
Company or Organization _____
_____
Address _____
_____
City _____
State or Province _____
ZIP or Postal Code _____
Telephone No. _____
Fax _____
Name of Operator or Responsible Supervisor _____
_____

Our LMI product is being used for:

___ Waste water treatment
___ Cooling water treatment
___ Boiler water treatment
___ Municipal water treatment
___ Fertilizer injection
___ Laboratory fluid metering
___ Fluoridation
___ Paper chemical feed
___ Domestic potable water
___ Swimming pool or therapy bath
___ Other _____
_____

The solution we will pump is:

(name or type) _____
supplied by (company) _____
of (location) _____
The concentration as pumped is approximately _____% by volume
Pressure at the injection point is ± _____ psi kPa bar (circle one
Pressure at the suction point is ± _____ psi kPa bar (circle one

I selected this LMI product because of:

_____ design features ___ price _____ quality reputation
___ other _____

I would like my LMI product better if: _____
_____

Please send additional information on LMI products to:

Name _____
Address _____
City _____ State _____
ZIP or Postal Code _____
Telephone No. _____

(Separate registration card here and return to LMI)

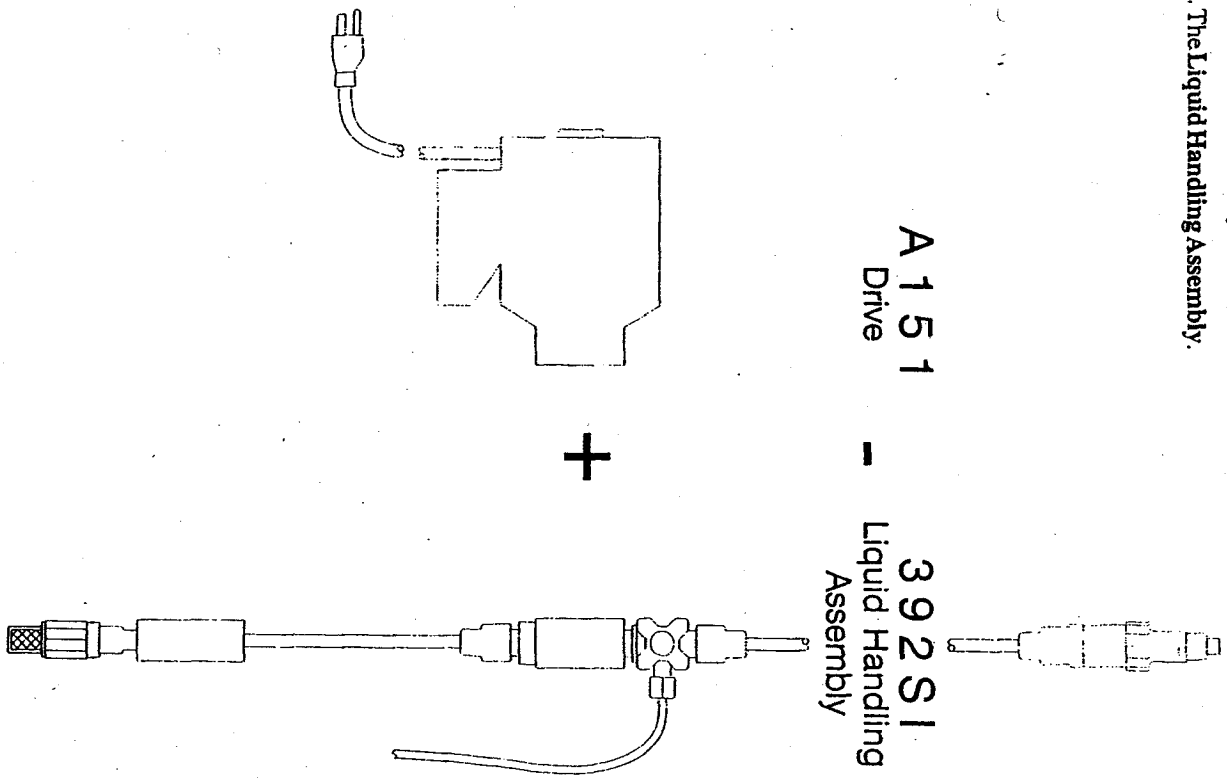
Your warranty registration card is attached above. Please fill it out and return it to LMI to register your warranty. If your registration card is not attached, please call LMI's Customer Service Group at (508) 263-9800, or fax us at (508) 264-9172.

Example:

Your pump consists of two main components:

1. The **Drive Assembly**; and
2. The **Liquid Handling Assembly**.

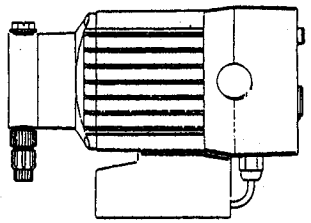
A151 Drive + 392SI Liquid Handling Assembly



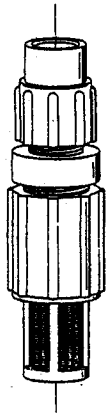
2.0 Unpacking Check List

Your carton will contain many or all of the following items. Please notify the carrier immediately if there are any signs of damage to the pump or its parts.

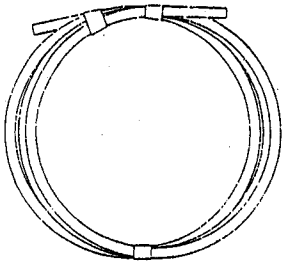
Please refer to the enclosed Drive Assembly Parts List Sheet for an illustration and electrical diagram of your complete pump.



Metering Pump



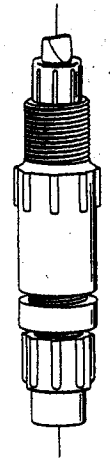
Foot Valve



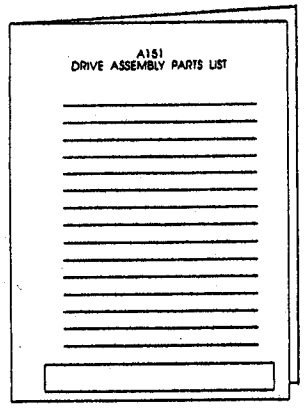
Tubing

Depending on the model, your carton may contain 0, 1, 2 or 3 rolls of tubing. Your carton may contain a roll of clear vinyl tubing; this is for connection to the SUCTION SIDE OF THE PUMP HEAD ONLY.

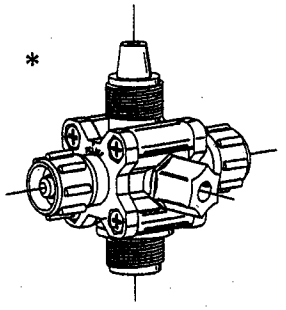
Ceramic Foot Valve Weight



Injection Check Valve



Drive Assembly Exploded View Drawing



MULTI-FUNCTION Valve and Tubing

* Your carton may or may not contain a 3-FV, 4-FV, or bleed 4-FV accessory.

3.0 Pre-Installation Instructions

The following precautions should be taken when working with LMI metering pumps. Please read this section carefully prior to installation.

Precautions

Protective Clothing

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to MSDS precautions from your solution supplier.

Water Pre-Prime

All LMI pumps are pre-primed with water when shipped from the factory. If your solution is not compatible with water, disassemble the Pump Head Assembly. Thoroughly dry the pump head, valves, seal rings, balls and Liquifram™ (diaphragm). Re-assemble head assembly tightening screws in a crisscross pattern. Refill the pump head with the solution to be pumped before priming the pump. (This will aid in priming.)

Solution Compatibility

Determine if the materials of construction included in the liquid handling portion of your pump are adequate for the solution (chemical) to be pumped. Should you have any further compatibility questions on your LMI Metering Pump, review the **LMI Chemical Resistance Chart** for compatibility. Contact your local LMI distributor or the LMI Customer Service Department for further information.

Tubing Connections

Inlet and outlet tubing or pipe sizes must not be reduced. Make certain that all tubing is SECURELY ATTACHED to fittings prior to start-up (see Section 4.3, Tubing Connections). ALWAYS use LMI supplied tubing with your pump, as the tubing is specifically designed for use with the pump fittings. It is recommended that all tubing be shielded to prevent possible injury in case of rupture or accidental damage.

Fittings And Machine Threads

All fittings should be hand-tightened. An additional 1/8 - 1/4 turn after the fitting contacts the seal ring may be necessary to provide a leak-proof seal. Excessive overtightening or use of a pipe wrench can cause damage to the fittings, seals, or pump head.

All LMI pumps have straight screw machine threads on the head and fittings and are sealed by the seal rings or O-rings. **DO NOT use Teflon® tape or pipe dope to seal threads. Teflon® Tape may only be used on the 1/2" NPT thread side of the Injection Check Valve as well as stainless steel liquid end connections.**

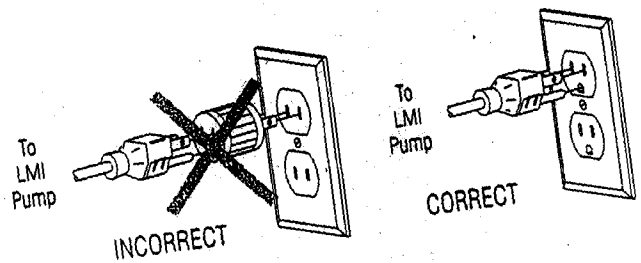
Plumbing

Always adhere to your local plumbing codes and requirements. Be sure installation does not constitute a cross connection. Check local plumbing codes for guidelines. LMI is not responsible for improper installations.

Electrical Connections

CAUTION

To reduce the risk of electrical shock, the metering pump must be plugged into a grounded outlet with ratings conforming to the data on the pump control panel. The pump must be connected to a good ground. **DO NOT USE ADAPTERS!** All wiring must conform to local electrical codes.



4.0 Installation

4.1 Pump Location and Installation

Locate pump in an area convenient to solution tank and electrical supply.

The pump should be accessible for routine maintenance, and should not be subjected to ambient temperatures above 122°F (50°C). If the pump will be exposed to direct sunlight, LMI black, UV resistant tubing should be installed.

4.2 Pump Mounting

The pump can be mounted in one of two ways:

A. **FLOODED SUCTION** (ideal installation); or

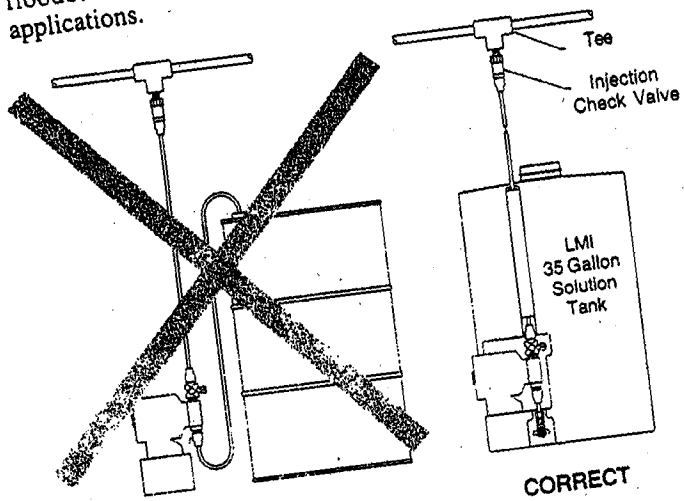
B. **SUCTION LIFT** - when suction lift is less than 5 feet (1.5 m) for solutions having a specific gravity of water. For denser solutions, consult distributor.

Your LMI metering pump must be mounted so that the suction and discharge valves are vertical. **NEVER position pump head and fittings horizontally.**

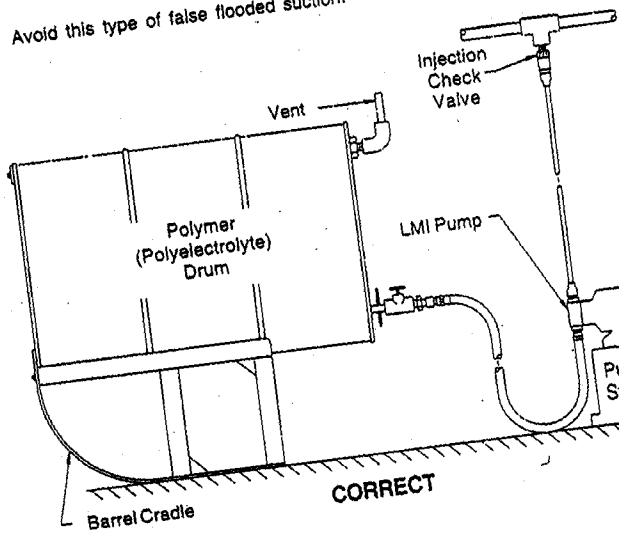
4.2.1 Flooded Suction

The pump is mounted at the base of the storage tank. This installation is the most trouble-free, and is recommended for very low outputs, solutions that gasify, and high-viscosity solutions. Since the suction tubing is filled with solution, priming is accomplished quickly and the chance of losing prime is reduced.

NOTE: Although popular for all solutions, LMI recommends flooded suction installations for all high-viscosity fluid applications.

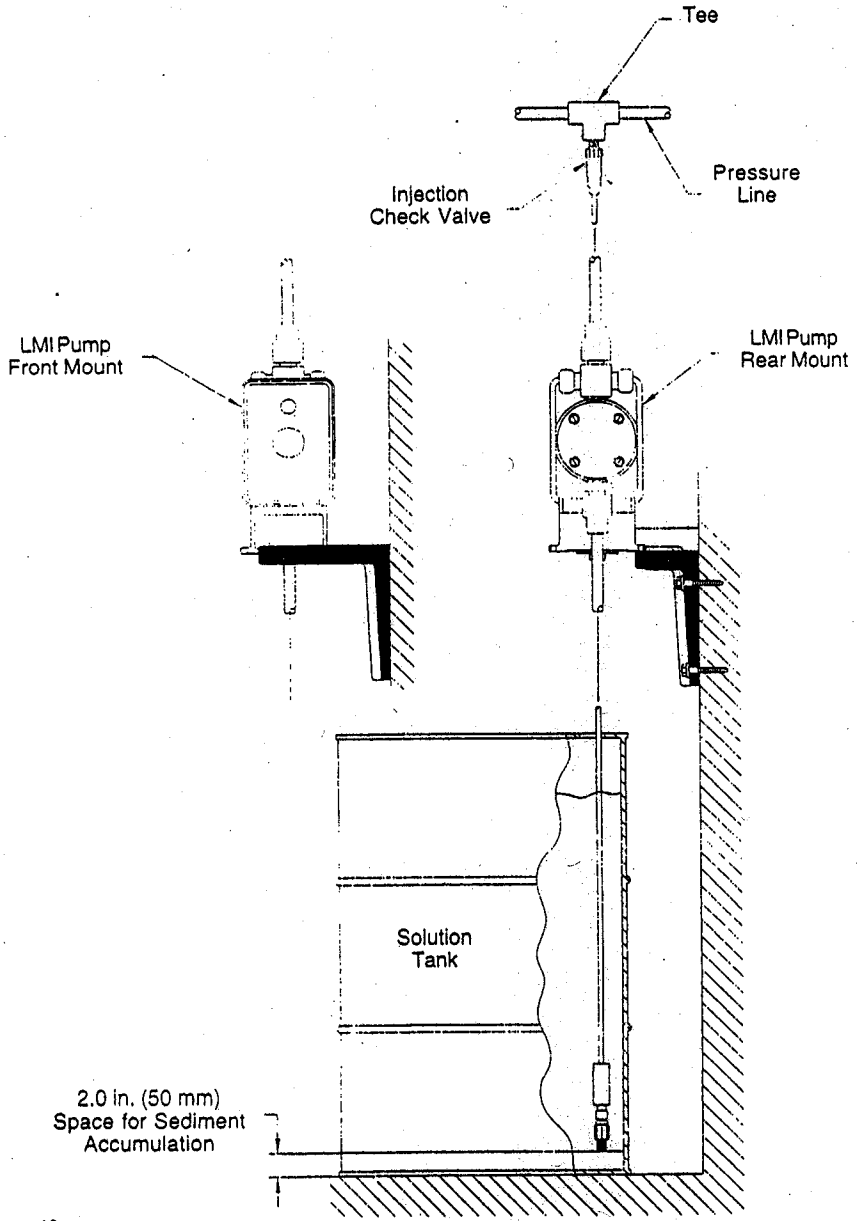


Avoid this type of false flooded suction.



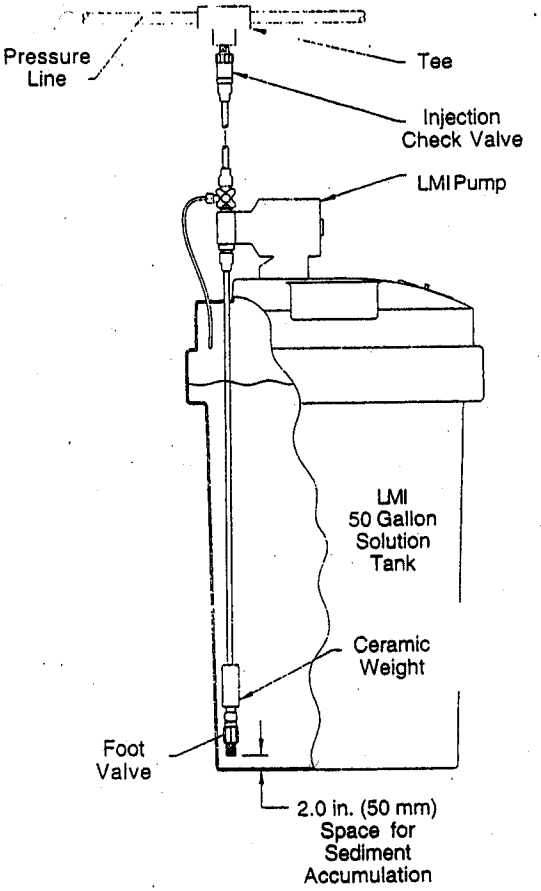
4.2.2 Suction Lift - Wall Bracket Mount

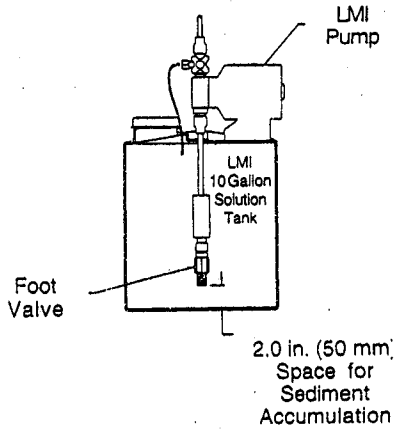
The pump may be mounted using an LMI Wall Mount Bracket Assembly (part no. 34643) directly above the solution tank. A pump mounted in this manner allows for easy changing of solution tanks or drums.



4.2.3 Suction Lift - Tank Mount

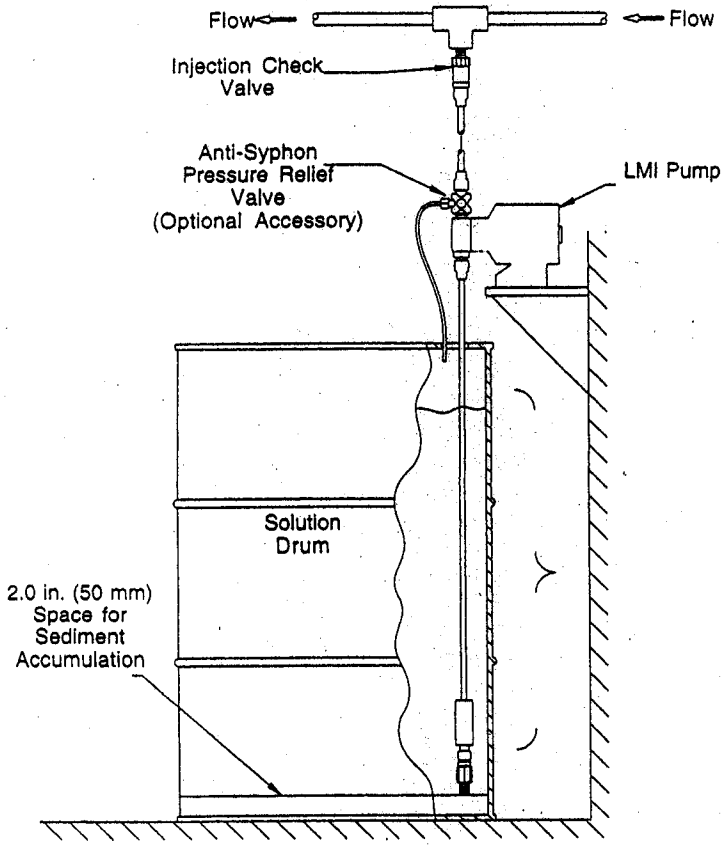
The pump may be mounted on a molded tank provided there is a recess to keep the pump stationary. LMI 10-gallon tank (part no. 27421), 35-gallon tank (part no. 27400), and 50-gallon tank (part no. 26350) have molded recesses for pump mounting.





4.2.4 Suction Lift - Shelf Mount

The pump may be mounted on a shelf (customer supplied) maintaining a suction lift of less than 5 ft (1.5 m). An LMI mounting kit (part number 10461) is available for securing the pump to a shelf.



4.3 Tubing Connections

CAUTION

A. Use only LMI tubing.

B. *DO NOT USE CLEAR VINYL TUBING ON THE DISCHARGE SIDE OF THE PUMP.* The pressure created by the pump can rupture vinyl tubing.

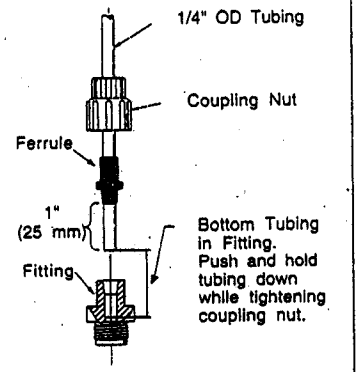
C. Before installation, all tubing must be cut with a clean square end.

D. Valve and head connections from the factory are capped or plugged to retain pre-prime water. Remove and discard these caps or plugs before connecting tubing.

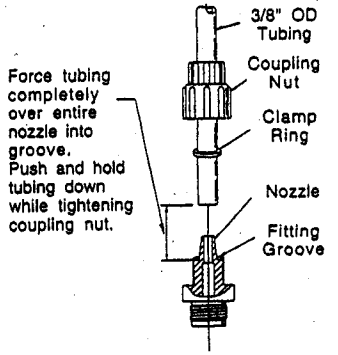
CAUTION

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.

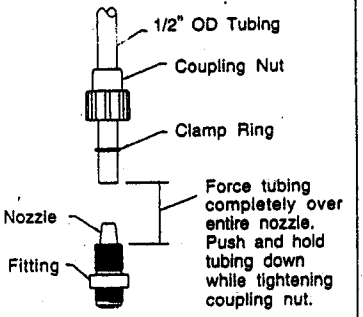
Tubing Connection 1/4" O.D. (.250") Tubing



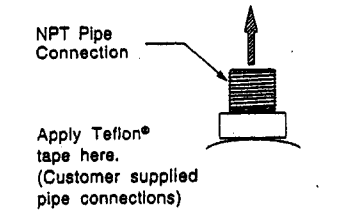
Tubing Connection 3/8" O.D. (.375") Tubing



Tubing Connection 1/2" O.D. (.5") Tubing



Pipe Thread Connection 1/4" or 1/2" NPT



4.4 Multi-Function Valves

Your pump may be equipped with one of the following multi-function valves: 3-FV, 4-FV, Bleed 4-FV, or standard discharge valve. If your pump is not equipped with a multi-function valve and you feel it is needed in your application, it can be purchased as an accessory. Contact your local LMI stocking distributor.

4.4.1 Three Function Valve (3-FV)

1. **Pressure Relief**

   If the discharge line is over pressurized, the valve opens sending solution back to the supply tank.

2. **Line Depressurization**

   Opening the relief knob provides line drain back to the supply tank.

3. **Priming Aid**

   Opening the relief knob assists in priming the pump by venting the discharge line to the atmosphere.

4.4.2 Four Function Valve (4-FV)

1. **Pressure Relief**

   If the discharge line is over pressurized, the valve opens sending solution back to the supply tank.

2. **Line Depressurization**

   Opening the relief knob provides line drain back to the supply tank.

3. **Anti-Syphon**

   Prevents syphoning when pumping solution downhill or into a vacuum.

4. **Back Pressure**

   Supplies approximately 25 psi back pressure to prevent overpumping when little or no system back pressure is present.

4.4.3 Bleed Four Function Valve (Bleed 4-FV)

1. **Line Depressurization**

   Opening the relief port provides line drain back to the supply tank.

2. **Anti-Syphon**

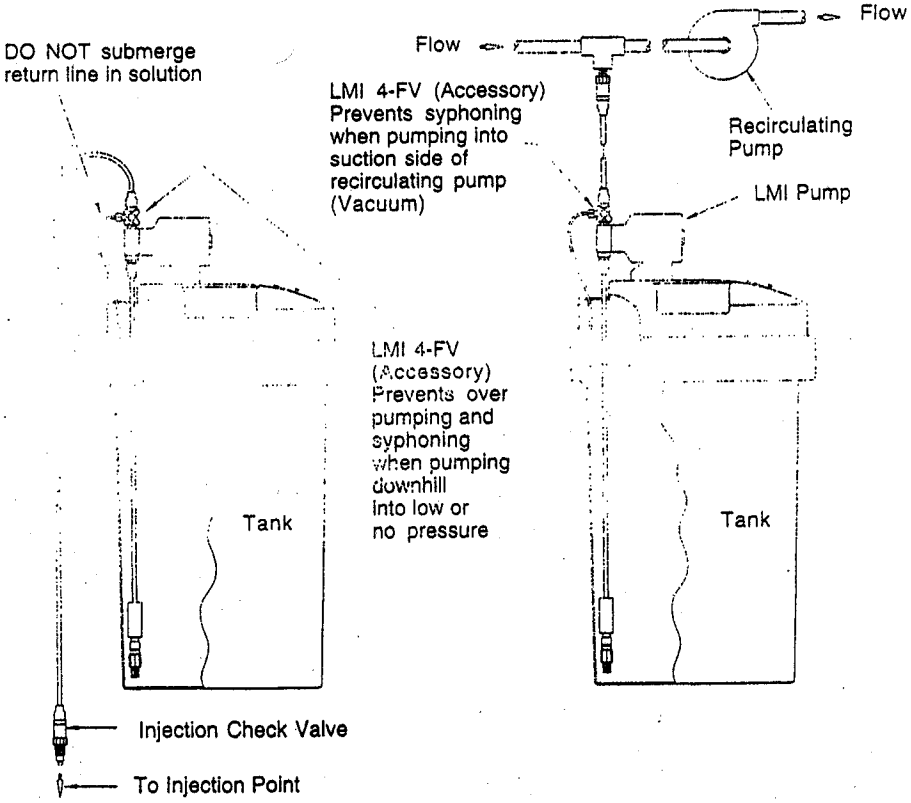
   Prevents syphoning when pumping solution downhill or into a vacuum.

3. **Back Pressure**

   Supplies approximately 25 psi back pressure to prevent overpumping when little or no system back pressure is present.

4. **Bleed Function**

   Manually adjusted valve provides continuous bleed of entrapped vapors from Sodium Hypochlorite or Hydrogen Peroxide.



Typical 4-FV Installation

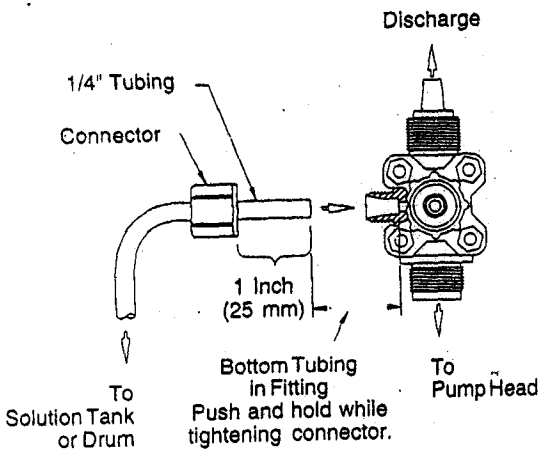
4.5 Multi-Function Valve Installation

To install the multi-function valve, remove the yellow screw cap on the top of the pump head and screw in the valve so that it contacts the seal ring. An additional 1/8 - 1/4 turn may be necessary to prevent leakage.

1/4" O.D. tubing connects to the side of the valve and acts as a return line to the solution tank. To ensure priming, this tubing must **NOT** be submerged in the solution.

CAUTION

This return line tubing must be secured to ensure pumped solution will safely return to supply tank.



Multi-Function Valve Tubing Connection

4.6 Foot Valve/Suction Tubing Installation

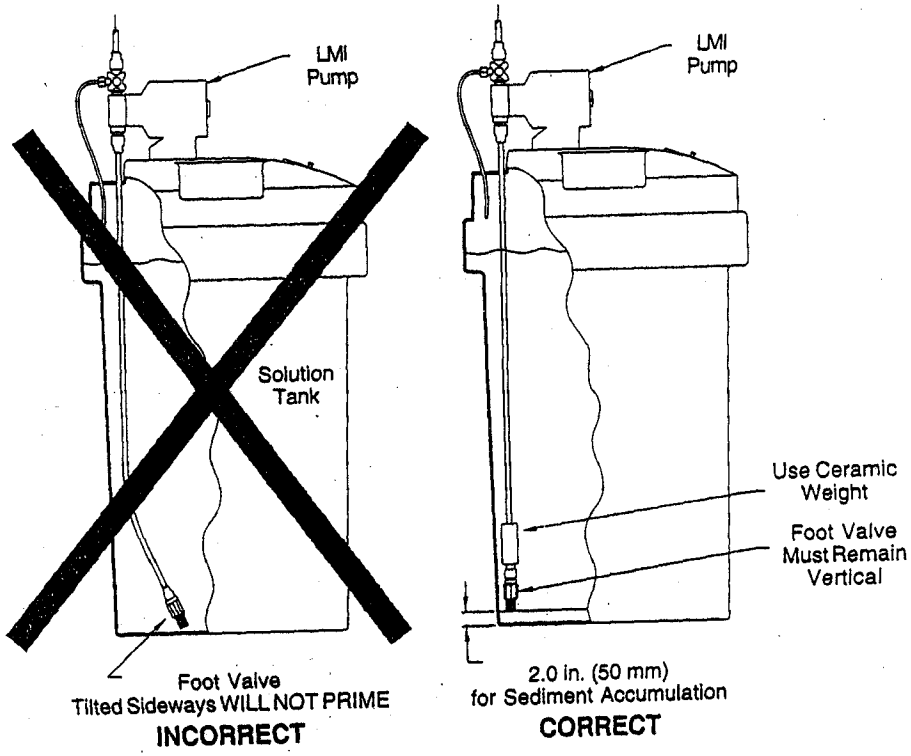
The Foot Valve acts as a check valve to keep the pump primed in suction lift applications.

The foot valve is designed to be submersed in the solution tank or drum and must sit in a vertical position at the bottom. Position approximately 2 inches (50 mm) off the bottom if the tank or drum contains sediment.

NOTE: Pump models equipped with high-viscosity liquid ends are not equipped with foot valves. Flooded suction is recommended. A 1/2" NPT connector is included for flooded suction installations.

The ceramic weight, when installed, positions the foot valve in a vertical position.

1. Attach the foot valve to one end of the suction tubing (see Tubing Connections, Section 4.3).
2. Slide the ceramic weight over the tubing end until it contacts the top of the foot valve coupling nut.
3. Place foot valve and tubing into the solution tank. Check that the foot valve is vertical and approximately 2 inches (50 mm) from the bottom of the tank or drum (see illustration). Connect the other end of the tubing to the suction side of the pump head (bottom side) (see Tubing Connections, Section 4.3).



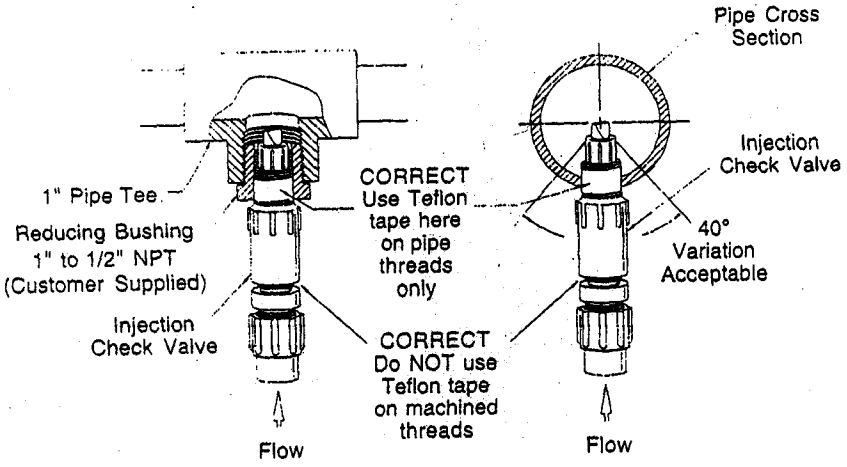
Proper Foot Valve Position

4.7 Injection Check Valve and Discharge Tubing Installation

The Injection Check Valve prevents backflow from a treated line. Connect the Injection Check Valve to your "DISCHARGE" (outlet) line. Any size NPTF fitting or pipe tee with a reducing bushing to 1/2" NPTF will accept the injection check valve. Use Teflon® tape or pipe dope to seal the pipe threads ***only***.

When installing the Injection Check Valve, be sure to position it so that the valve enters the bottom of your pipe in a vertical position. Variations left and right within 80° are acceptable (see illustration below).

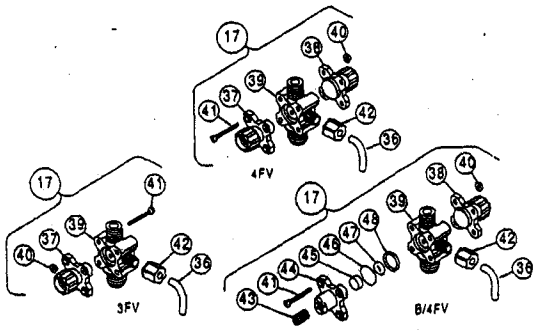
After cutting an appropriate length of tubing, connect tubing to the injection check valve then back to the discharge side of the pump head valve or discharge fitting (top side), making sure it does not crimp or come into contact with hot or sharp surfaces (see Tubing Connections, Section 4.3).

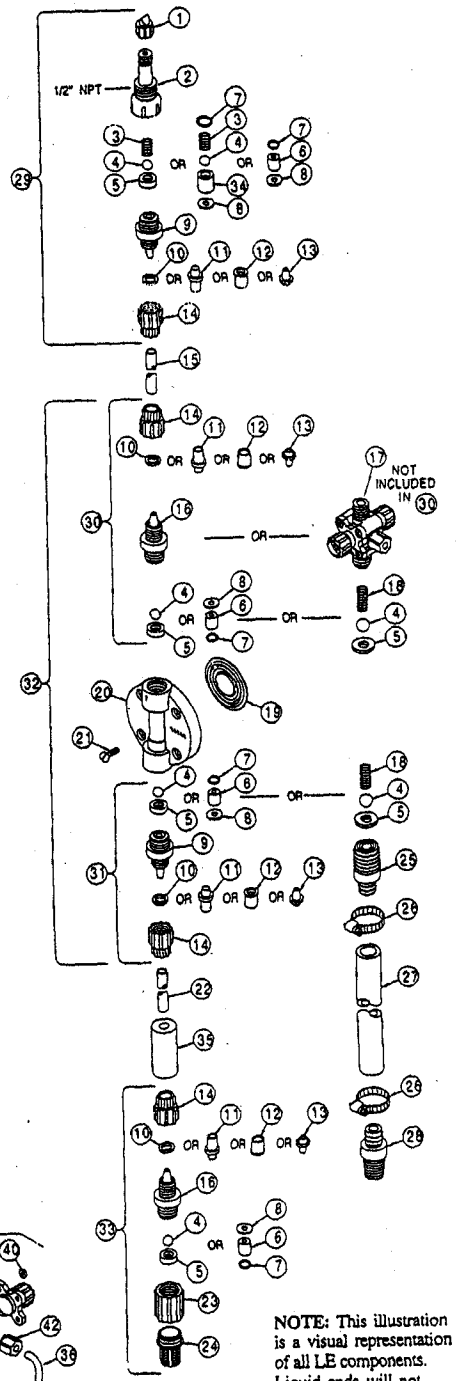


Typical Injection Check Valve Installations

5.0 Liquid End Parts List

1 Flapper valve
2 Injection check valve body
3 Injection check valve spring
4 Check valve ball
5 Seal ring
6 Cartridge valve
7 Cartridge valve o-ring
8 Cartridge valve washer
9 Valve seat
10 Clamp ring
11 Ferrule
12 Clamp sleeve
13 Tubing adapter
14 Coupling nut
15 Discharge tubing
16 Valve housing
17 Multi-function valve
18 High-viscosity spring
19 Liquifram
20 Pump head
21 Pump head screw
22 Suction tubing
23 Foot valve seat
24 Foot valve screen
25 High-viscosity valve seat
26 H.V. tubing clamp
27 H.V. suction tubing
28 H.V. Tubing x 1/2 NPT connector
29 Injection check valve assembly
30 Discharge valve assembly
31 Suction valve assembly
32 Pump head assembly
33 Foot valve assembly
34 Injection Seat PTFE
35 Ceramic Weight
36 Return Line
37 Cap ASM (Black Knob)
38 Cap ASM (Yellow Knob)
39 Multi-Function Valve Body
40 Nut Multi-Function Valve
41 Screw Multi-Function Valve
42 Return Line Coupling Nut
43 Adjustment Screw B/4-FV
44 Cap B/4-FV
45 Plug B/4-FV
46 Gasket B/4-FV
47 Small O-Ring B/4-FV
48 Large O-Ring B/4-FV





NOTE: This illustration is a visual representation of all LE components. Liquid ends will not include all parts shown.

6.0 Start-up and Adjustment

a.) The pump is normally self-priming if suction lift is 5 ft (1.5m) or less and the steps below are followed.

b.) Pumps are shipped from the factory with water in the pump head to aid in priming.

6.1 Output Adjustment Controls

Manual series pump controls are not equipped with pressure control.

1. Pressure Control Adjustment (if equipped): Pressure control provides the adjustment of the pump's pressure capability and power consumption, reducing heat, pipe shock and pulsation while increasing pump life. See Section 7.0 after priming for proper adjustment settings.
2. Speed Adjustment (Upper Knob) (if equipped): Speed control provides adjustment of the percent of maximum strokes per minute. Turning this knob clockwise ↻ increases stroke frequency (speed).
3. Stroke Adjustment (Lower Knob): Stroke control provides adjustment of the percent maximum of solution discharged during each pump actuation. Turning this knob clockwise ↻ increases solution displacement.

A7 Series Only: When operating the pump in external mode, the speed control knob should be turned fully counter-clockwise ↺. A click indicates pump is in external mode.

A34 and A37 Series Only: Pump comes equipped with a range selector switch which provides high or low speed adjustment. The high setting provides speed adjustments between 8 and 100 strokes per minute. The low setting provides accurate speed adjustments between 1 and 12.5 strokes per minute for applications requiring infrequent stroking.

6.2 Start-Up/Priming for Pump Supplied with Multi-Function Valve

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now start priming the pump.

1. Plug in or switch the pump on.
2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

If the pump is equipped with pressure control, turn fully clockwise ↻.

3. 1/4 turn open the relief side (black knob) of the multi-function valve.

3A. (Bleed 4FV only) With screwdriver rotate bleed adjustment screw counter-clockwise ↺. 2 full turns. When solution begins to flow through translucent bleed return tubing, the pump is primed. Stop pump.

4. The suction tubing should begin to fill with solution from the tank.
5. A small amount of solution will begin to discharge out the return line of the multi-function valve. Once this happens, 1/4 turn or release the knob and **SHUT THE PUMP OFF.** (If pump is not equipped with an on/off switch, disconnect the power cord.)
6. The pump is now primed.

6A. (Bleed 4FV only)

a. Start pump and let pump inject solution into the discharge line.

b. Close the bleed adjustment screw by rotating it clockwise ↻ with a screwdriver.

c. Now adjust the pump stroke length and/or speed (frequency) to a range approximately 25% higher than you would normally want for the process.

d. Slowly rotate bleed adjustment screw counter-clockwise ↺, until just a small amount of solution begins to trickle

down inside the bleed return tubing. A small amount of solution pumped back to the tank with each stroke of the pump will allow gas and air to escape without air or gas locking in the pump head.

7. Proceed to output adjustment, Section 6.4.

If the pump does not self-prime, remove the multi-function valve on the discharge side of the pump head. Remove the check valve and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.3 Start-Up/Priming without Multi-Function Valve

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now prime the pump.

1. Plug in or switch on the pump.
2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

If the pump is equipped with pressure control, turn fully clockwise.

3. The suction tubing should begin to fill with solution from the tank.
4. Once the solution begins to exit the pump head on the discharge side, **SHUT THE PUMP OFF**. (If pump is not equipped with an on/off switch, disconnect the power cord).
5. The pump is now primed.

6. Proceed to output adjustment, Section 6.4.

If the pump does not self-prime, remove the fitting on the discharge side of the pump head. Remove the ball and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.4 Output Adjustment

Once the pump has been primed, an appropriate output adjustment **MUST** be made. Pump output should be calculated and adjustments made accordingly.

6.5 Total Pump Output

Calculate the total output of the pump as follows:

PUMP OUTPUT = MAX PUMP OUTPUT × % SPEED × % STROKE

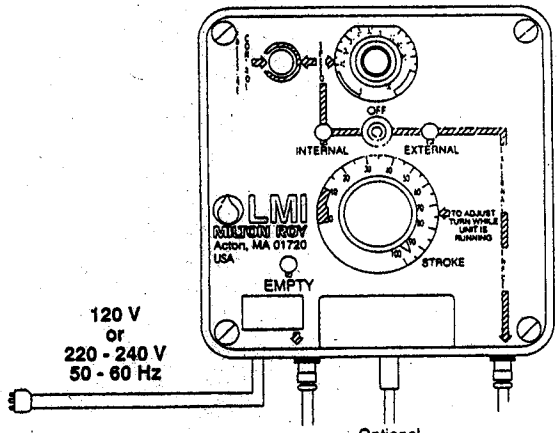
Example: A151-392SI

Use MAX Output (from dataplate on bottom center of pump control panel) = 24 GPD (24 gallons per day).

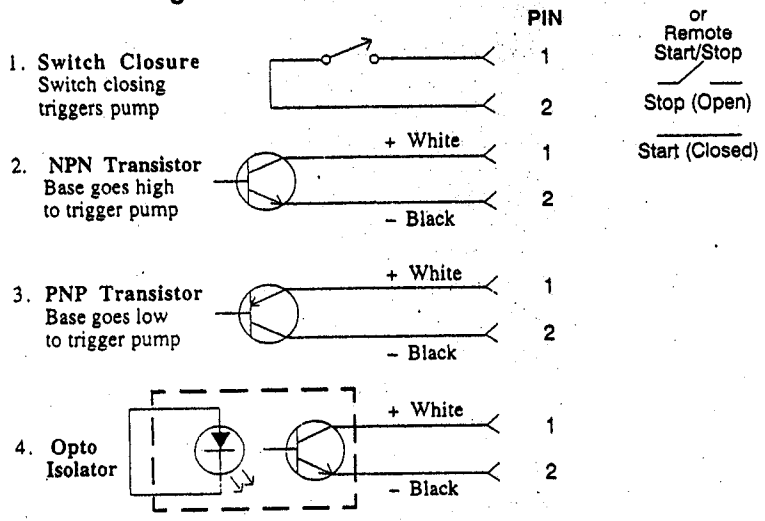
If the pump is set at 60% speed and 70% stroke length, the approximate pump output is:

24.0×0.60×0.70=10.08 GPD (gallons per day). Divide by 24 (hours in one day) to calculate in gallons per hour.

If pump is not equipped with speed adjustment, calculate by ***Max Pump Output × % Stroke*** *only.*

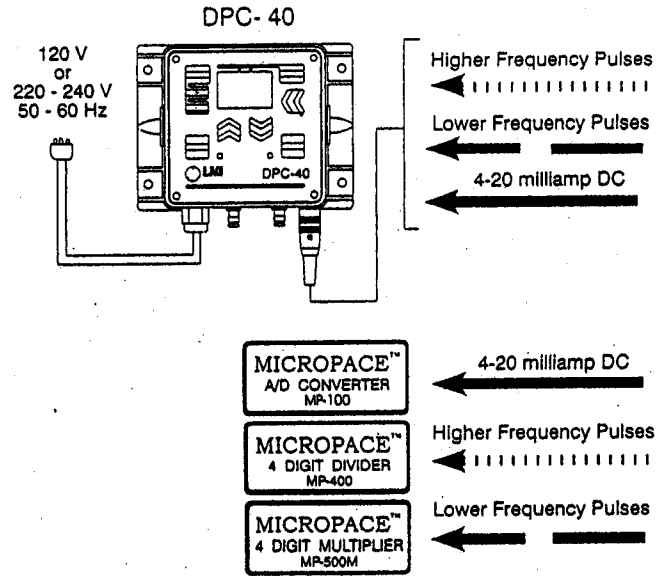


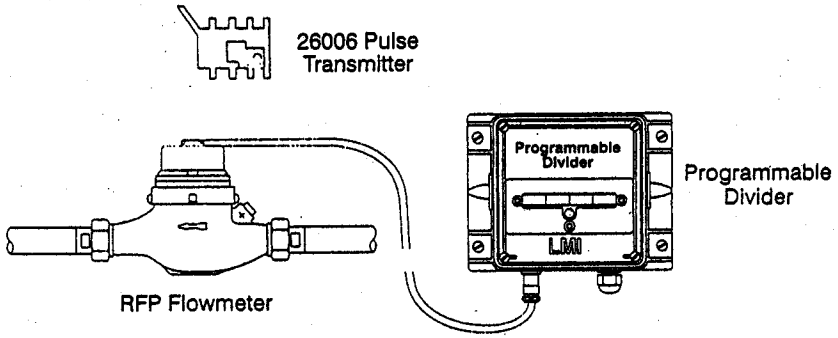
Method of Triggering LMI Pump Through 4-Pin Connector

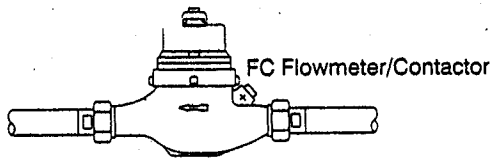


Note

Switch or transistors must be capable of switching 15V DC at 2 milliamperes. Minimum time in low impedance state (ON) is 50 milliseconds. Minimum time in high impedance state (OFF) is 100 milliseconds.







8.0 Calibration

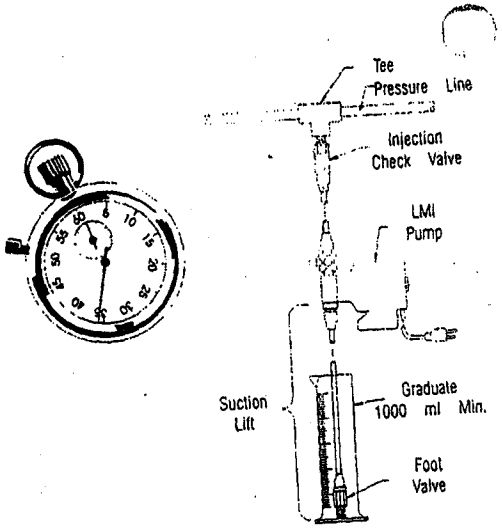
Once installation is complete and the approximate output has been determined, the pump should be calibrated to adjust speed and stroke for your actual desired output. (Calibration cylinders may be purchased from your local LMI distributor, ref. publication 1798.)

1. Be sure the pump is primed, and discharge tubing and Injection Check Valve are installed as they would be in normal service (i.e., including factors such as injection pressure, fluid viscosity, and suction lift).
2. Place the Foot Valve in a graduated container with a volume of 1000 ml or more.
3. Plug in and switch pump to Internal Mode. Pump until all the air is exhausted from the suction line and head.
4. Turn the pump off. Refill graduated container to a level starting point.

Note

If pump is equipped with pressure control, see Section 8.1 before proceeding.

5. Using a stopwatch or timer, turn the pump on for a measured amount of time (50 pump strokes minimum). The longer the time period, the more confident you can be of the results. Be sure to count the number of strokes during the calibration period when making comparisons.
6. Turn the pump off. Note the time elapsed in relation to volume displaced in the graduate. Now, calculate the output in the time unit you choose (minutes, hours, days, etc.).
7. If the output is too low or too great, adjust speed and or stroke, estimating required correction and repeat steps 1-7.

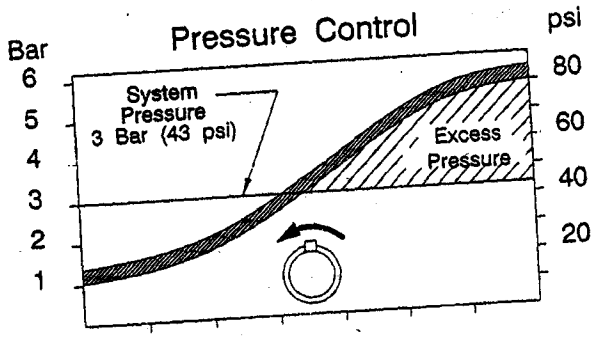


8.1 Pressure Control

Adjust Pressure Control: While unit is running, turn Pressure Control Potentiometer slowly counter-clockwise until unit just begins to stall. From this stall point, now turn Pressure Control Potentiometer clockwise halfway between the stall point and maximum setting. This is the optimum pressure control setting for your application.

Note

Increase setting if back pressure is increased. Adjusting pressure control decreases pressure rating of pump.



Adjust pressure control to reduce heat, shock, and pulsations; and to prolong pump life.

8.2 Calibration Procedure - On-Site Volumetric Calibration in External Mode

1. Since pump output is governed by an external device such as Flowmeter-Pulser, Liquitron™ Controller, or 4-20 mA DC signal from an instrument with an LMI Analog-to-Digital Converter, **only the output per stroke may be calibrated.**
2. With pump primed and discharge tubing connected to the injection point as it would be in normal service, place Foot Valve and Strainer Assembly in a graduated container with a volume of 500 ml or more.
3. Switch pump to **Internal** mode with Speed Knob set at 100 until air is exhausted from suction line and pump head.
4. **Adjust Pressure Control (if desired)** - See Section 8.1.
5. Switch pump **OFF** and note solution level in graduated container. Refill graduate to a starting point.
6. Switch pump **ON** and **count the number of strokes** for exactly one minute, then switch pump **OFF**.
7. Note volume pumped during the calibration period of one minute. Divide into this the number of strokes to determine the volume of solution pumped per stroke.

   Example: 500 ml in 100 strokes = 5.0 ml per stroke.

   Multiply this by your expected stroke rate per minute, per hour or per day and compare with desired output requirements.
8. Adjust Stroke Length Knob (lower knob) to your best estimate of required correction and repeat calibration procedure.

9.0 Spare Parts Replacement Routine Maintenance

9.1 Depressurizing the Discharge Line (For Pumps Equipped with a 3-FV or a 4-FV only)

ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

Read steps 1 and 2 below before proceeding.

1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has been installed downstream of the Injection Valve, it should be closed.

Be sure your relief tubing is connected to your multi-function valve and runs back to your solution drum or tank.

2. 1/4 turn the black knob on the valve. The discharge line is now depressurized. Keep valve open until solution drains back down the discharge tubing into solution drum or tank. Then 1/4 turn knob to normal position.

9.2 Liquifram™ (Diaphragm) Replacement

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

LMI metering pumps are designed for trouble-free operation, yet routine maintenance of elastomeric parts is essential for optimum performance. This involves replacing the Liquifram™, cartridge valves or seal rings/valve balls, and the injection check valve spring. LMI recommends replacing these parts at least once a year; however, frequency will depend on your particular application.

When replacing the Liquifram™, the cartridge valves or seal rings/valve balls, and the injection check valve spring spring should also be replaced (see next Section 9.3). A Spare Parts Kit (SP-#) or RPM Pro Pac™ kit containing these parts may be obtained from your local distributor.

Replacing the Liquifram:™

1. Carefully depressurize, drain, and disconnect the discharge line (see Section 8.1 in this manual). Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump head has been flushed, lift the Foot Valve out of the solution and continue to pump air into the pump head until the pump head is purged of water or neutralizing solution.

Note

If the liquid cannot be pumped due to Liquifram™ rupture using protective clothing, gloves and face shield, carefully disconnect the suction and discharge tubing. Remove the four screws to the head and immerse the head in water or other neutralizing solution.

2. Start the pump. While running, set the stroke knob to zero and turn the pump off.

Note

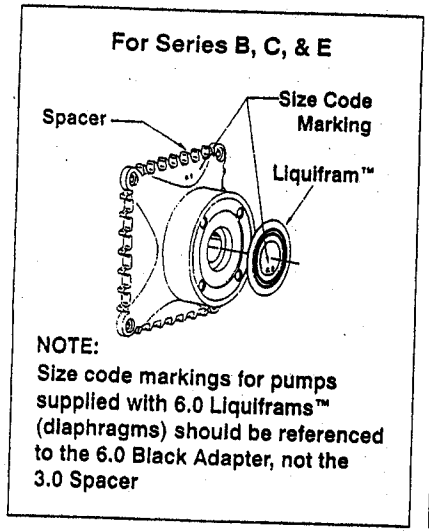
See Section 10.0 for proper zero.

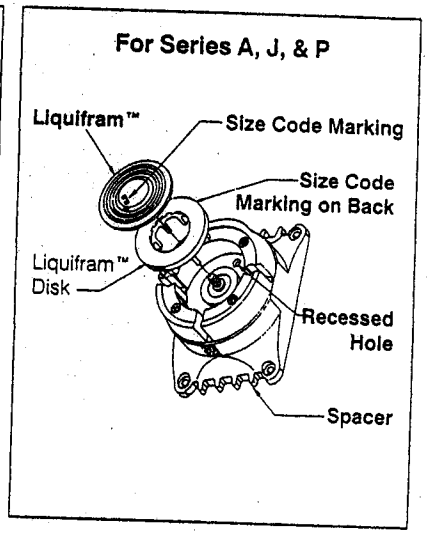
3. With the unit off, unscrew the Liquifram™ by carefully grasping the outer edge and turning it counter-clockwise ↺. Discard old Liquifram™. Remove the Liquifram™ disk if so equipped (located behind the Liquifram™) and check that the size code matches the size code on the replacement Liquifram™ (see illustration).

4. Reinstall the disk so the alignment pin on the disk (if present) seats in the recessed hole in the EPU.

CAUTION

Be careful not to scratch the Teflon® face of the new Liquifram™.





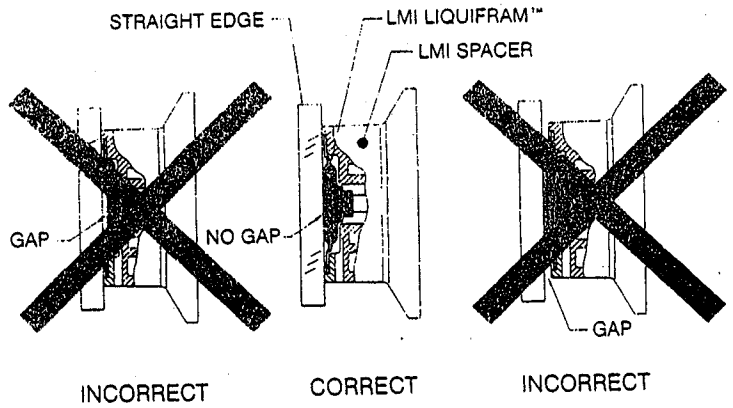
5. Start the pump and turn the stroke knob to the setting indicated on the following Stroke Setting Chart which matches the pump series number located on the pump dataplate. With the pump stroking (running), screw on the new Liquifram™ clockwise ↻ until the center begins to buckle inwards. Stop the pump.

Liquifram™ Stroke Setting Chart

Pump Series	Stroke Knob Setting
All A, B, J, P, Z Series C10, C11, C12, C70, C71, C72, E70, E71, E72	90%
All L Series	85%
C78	50%
C13, C14, C73, C74, C77 E73, E74	70%
All M Series	100% *

* Liquifram™ on M Series pumps only, must be bottomed completely (turned all the way in). ***Do Not Use Straight Edge.***

6. Grasp the outer edge of the Liquifram™ and adjust by screwing it in or out so that the center of the Liquifram™ is flush with the outside of the spacer edge (see illustration below).



(Liquifram™ is flush with spacer and straight edge.)

7. Once the Liquifram™ is properly positioned, remount the pump head to the spacer using the four (4) screws. Tighten in a criss-cross pattern. After one week of operation, recheck the screws and tighten if necessary.

APPENDIX B

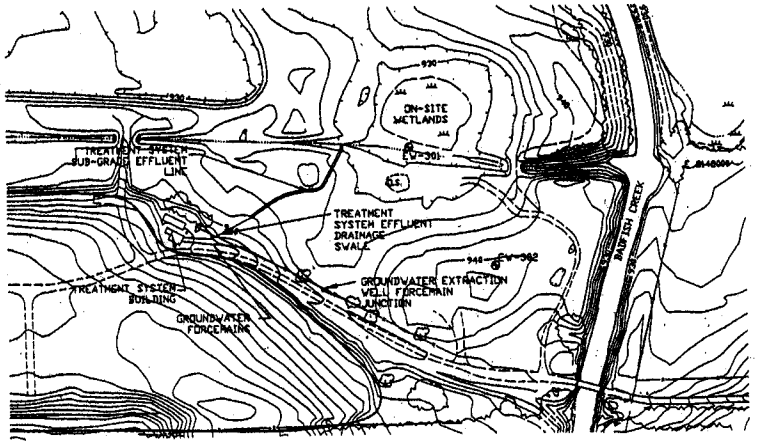
ARCADIS

Appendix B

As-Built Drawings

CITY DISPOSAL CORPORATION LANDFILL
DUNN, WISCONSIN
GROUNDWATER CONTROL OPERABLE UNIT
AS-BUILT DRAWINGS

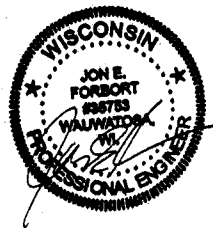
Prepared by: **ARCADIS**

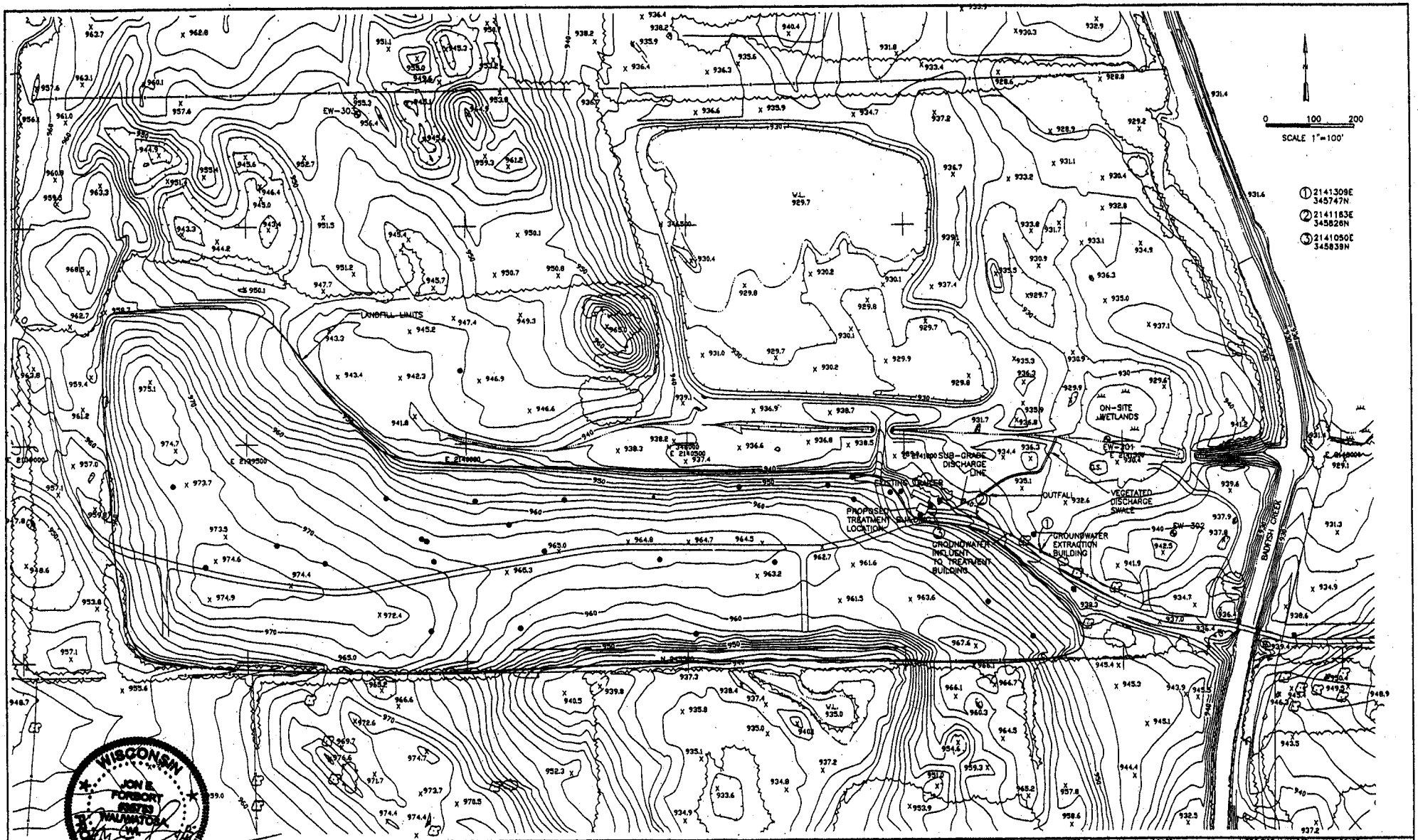


PLAN

DRAWING LIST

DRAWING NO. C-1	SITE PLAN
DRAWING NO. C-2	TREATMENT SYSTEM PLAN
DRAWING NO. PID-1	PIPING AND INSTRUMENTATION DIAGRAM
DRAWING NO. PID-2	PIPING AND INSTRUMENTATION DIAGRAM
DRAWING NO. PID-3	PIPING AND INSTRUMENTATION DIAGRAM
DRAWING NO. PID-4	PIPING AND INSTRUMENTATION DIAGRAM LEGEND SHEET NO. 1
DRAWING NO. PID-5	PIPING AND INSTRUMENTATION DIAGRAM LEGEND SHEET NO. 2
DRAWING NO. M-1	TREATMENT SYSTEM EQUIPMENT LAYOUT
DRAWING NO. M-2	TREATMENT SYSTEM PIPING LAYOUT
DRAWING NO. E-1	ELECTRICAL LEGEND AND CONDUIT SCHEDULE
DRAWING NO. E-2	ELECTRICAL ONE-LINE DIAGRAM
DRAWING NO. E-3	ELECTRICAL LAYOUT PLAN
DRAWING NO. S-1	TREATMENT BUILDING FOUNDATION PLAN
DRAWING NO. S-2	TREATMENT BUILDING FOUNDATION DETAILS
DRAWING NO. S-3	TREATMENT BUILDING PLAN/ELEVATIONS
DRAWING NO. S-4	TRENCH DETAILS





WISCONSIN
JON E. FORBORT
E-32578
WAUWATOSA
WI
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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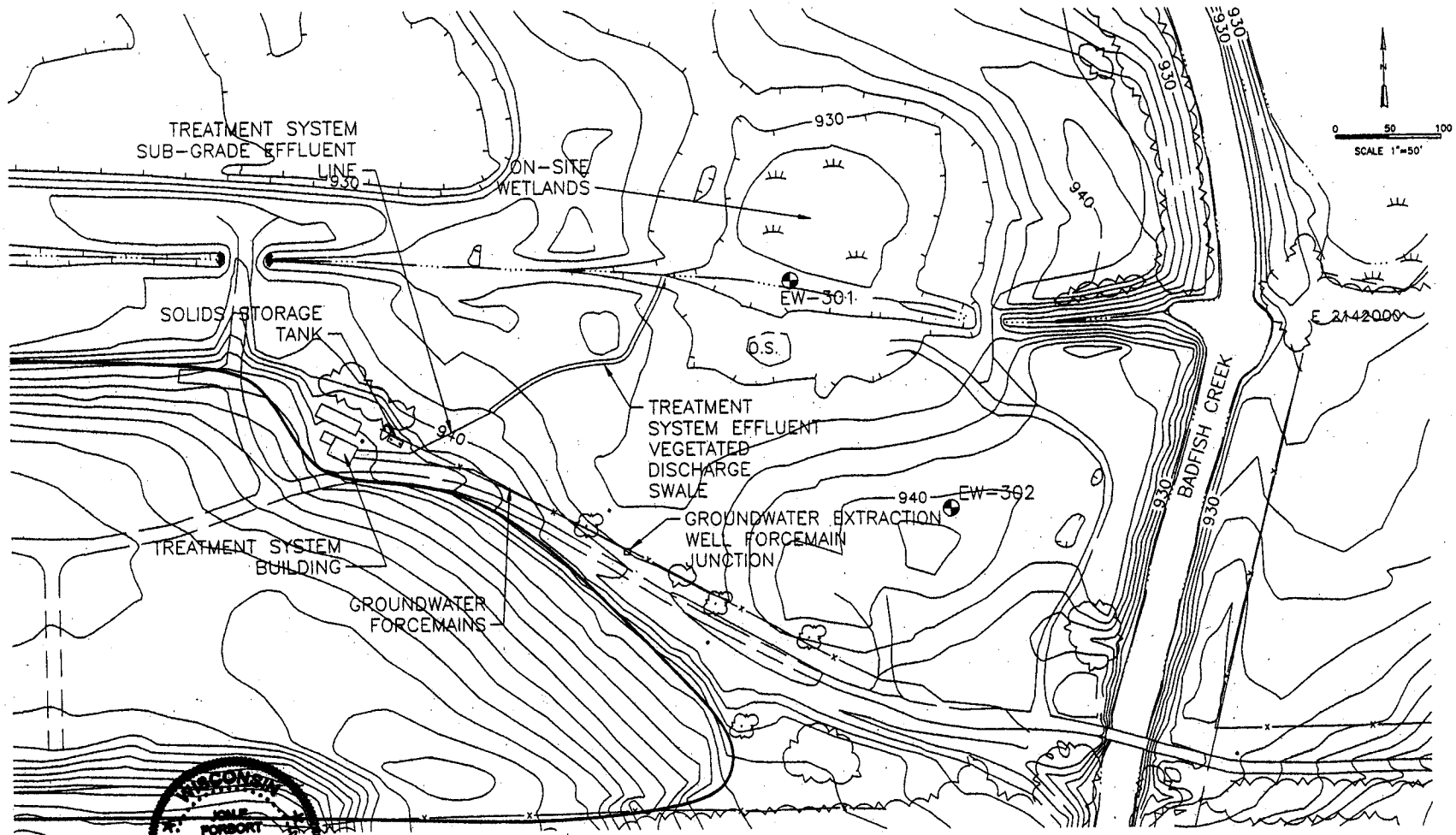
Tel: 414/276-7742 Fax: 414/276-7603

WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

SITE PLAN

DRAWN	DATE	PROJECT MANAGER	CHECKED
WMAY	10/14/98	JFORBORT	JFORBORT
		FILENAME	PLOT SCALE
		C-1.DWG	AS NOTED
		PROJECT NUMBER	DRAWING NUMBER
		WI0007430001	C-1



WISCONSIN
JOHN F. PORBORT
E-35783
WAUWATOSA
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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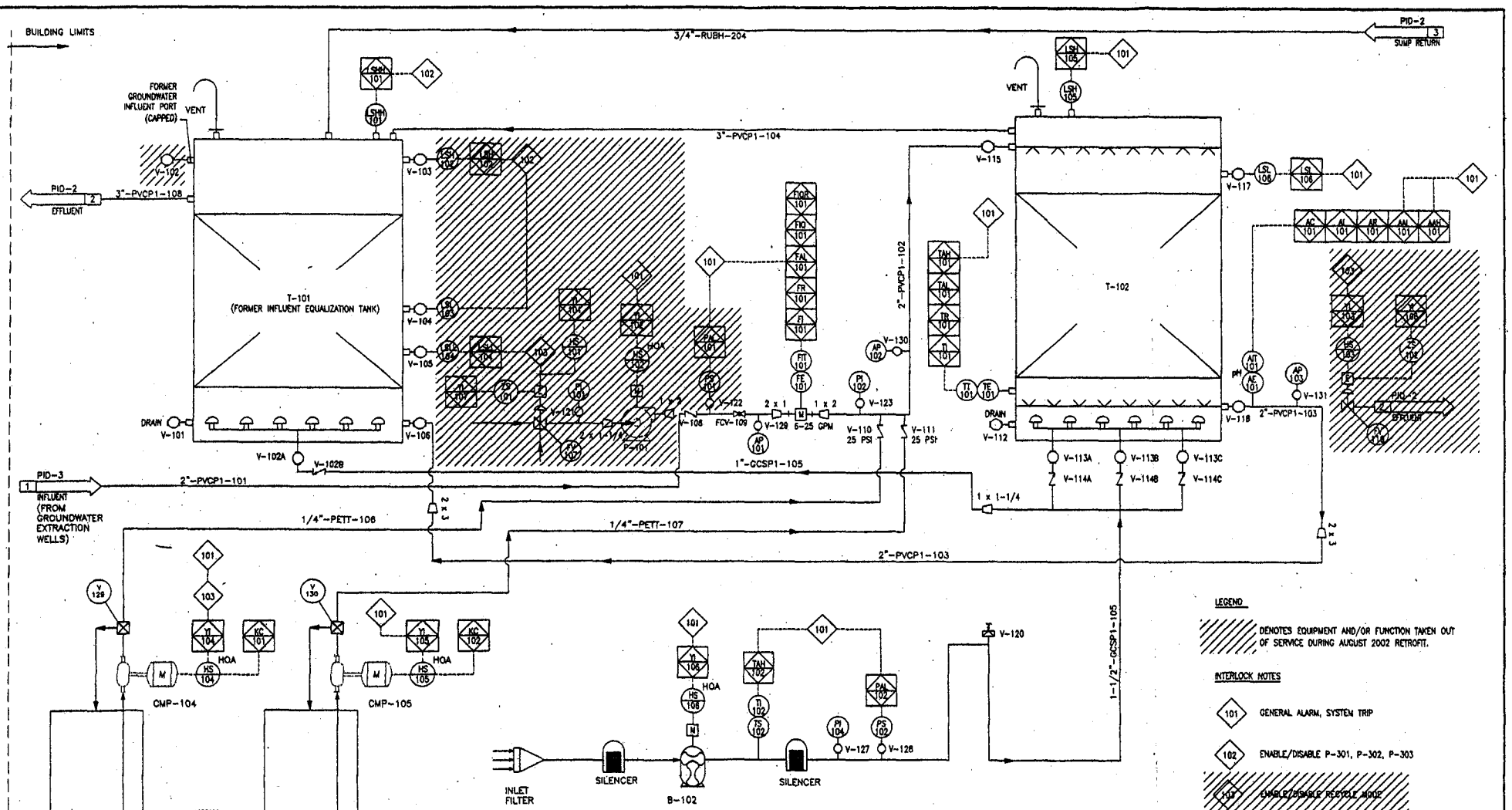
WASTE MANAGEMENT INC.
CITY DISPOSAL
CORPORATION LANDFILL
DUNN, WISCONSIN

TREATMENT SYSTEM PLAN

DRAWN	DATE	PROJECT MANAGER	CHECKED
JELLIOTT	5/29/00	JFORBORT	JFORBORT
		FILENAME C-2.DWG	PLOT SCALE AS NOTED
		PROJECT NUMBER WI000743	DRAWING NUMBER C-2

LAST EDITED: 05.29.00 LAST EDITED: WASTEMGMT/WI0743/TREAT_SYS/CAD/AS-BUILT/C-2.DWG BORDER INFORMATION: ANSI D (22" X 34")



T-101	T-102	B-102	P-101	CMP-104	CMP-105	T-104	T-105
LAG FIXED-FILM BIOREACTOR	LEAD FIXED-FILM BIOREACTOR	AERATION BLOWER	INFLUENT PUMP	CARBON SUBSTRATE METERING PUMP	NUTRIENT METERING PUMP	CARBON SUBSTRATE FEED TANK	NUTRIENT FEED TANK
CAPACITY: 3,000 GALLON MATERIAL: HDPE CONTENTS: GROUNDWATER MODEL: POLY PROCESSING	CAPACITY: 4,500 GALLON MATERIAL: HDPE CONTENTS: GROUNDWATER, BIOMASS MODEL: VARIES	TYPE: ROTARY BLOWER CAPACITY: 40 CFM @ 6 PSIG. MODEL: KAISER	TYPE: CENTRIFUGAL CAPACITY: 25 GPM @ 210' TDH MATERIAL: DUCTILE IRON MODEL: ANDERSON-DRESSER 5HP / 1PH / 240V / 1 PH, 60 HZ.	TYPE: DIAPHRAGM CAPACITY: 0 - 25 ML/MIN MATERIAL: CERAMIC, POLY MODEL: LMI	TYPE: DIAPHRAGM CAPACITY: 0 - 25 ML/MIN MATERIAL: CERAMIC, POLY MODEL: LMI	CAPACITY: 55 GALLON DRUM (OR 500 GALLON TOTE) MATERIAL: STEEL CONTENTS: CARBON SUBSTRATE SOLUTION	CAPACITY: 55 GALLON DRUM (OR 500 GALLON TOTE) MATERIAL: STEEL CONTENTS: NUTRIENT SOLUTION

JON E. FORBORT
E36753
WAUWATOSA
WI
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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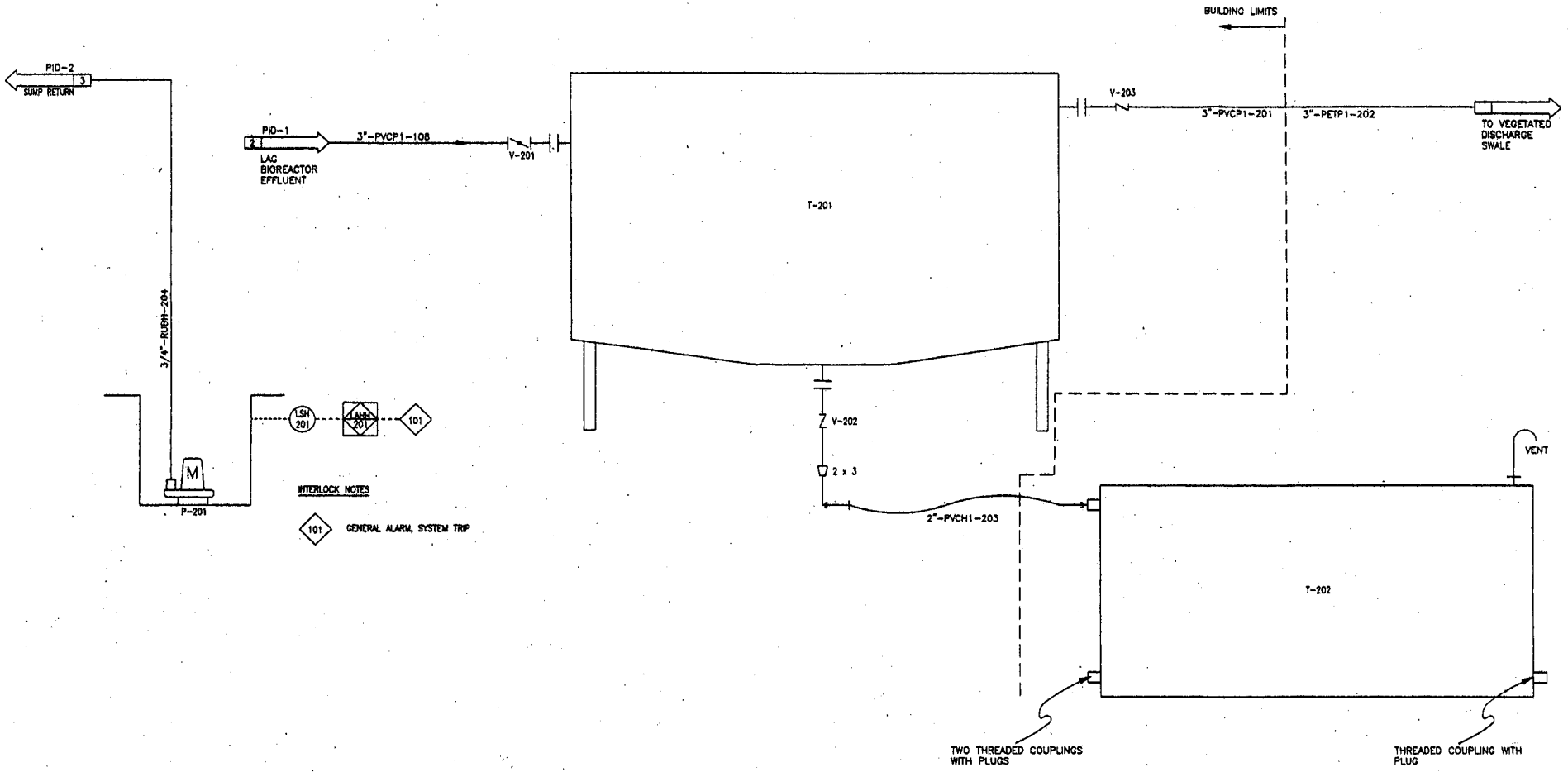
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

PIPING AND INSTRUMENTATION DIAGRAM

DRAWN	DATE	PROJECT MANAGER	CHECKED
TMAT	9/16/98	JFORBORT	JFORBORT
		FILENAME: PID1.DWG	PLOT SCALE: 1:1
		PROJECT NUMBER: W000743.0001	DRAWING NUMBER: PID-1



T-201	T-202	P-201	-	-	-	-
INCLINED PLATE CLARIFIER	SOLIDS STORAGE TANK	SUMP PUMP	-	-	-	-
MATERIAL: CARBON STEEL CONTENTS: GROUNDWATER, SLUDGE MODEL: IPC-2-110	CAPACITY: 3,000 GALLON MATERIAL: CARBON STEEL CONTENTS: BIOLOGICAL SLUDGE MODEL: VARIES	TYPE: SUBMERSIBLE CAPACITY: 10 GPM @ 12' TDH MODEL: FLO-TEC	CAPACITY: MATERIAL: CONTENTS: MODEL:	CAPACITY: MATERIAL: CONTENTS: MODEL:	CAPACITY: MATERIAL: CONTENTS: MODEL:	CAPACITY: MATERIAL: CONTENTS: MODEL:

WISCONSIN
JON E. FORBORT
#35753
WAUWATOSA
WI
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
2	2/03	AS-BUILT DOCUMENTATION	JF	
1	2/00	CLARIFIER FLANGE SIZES	JF	JF

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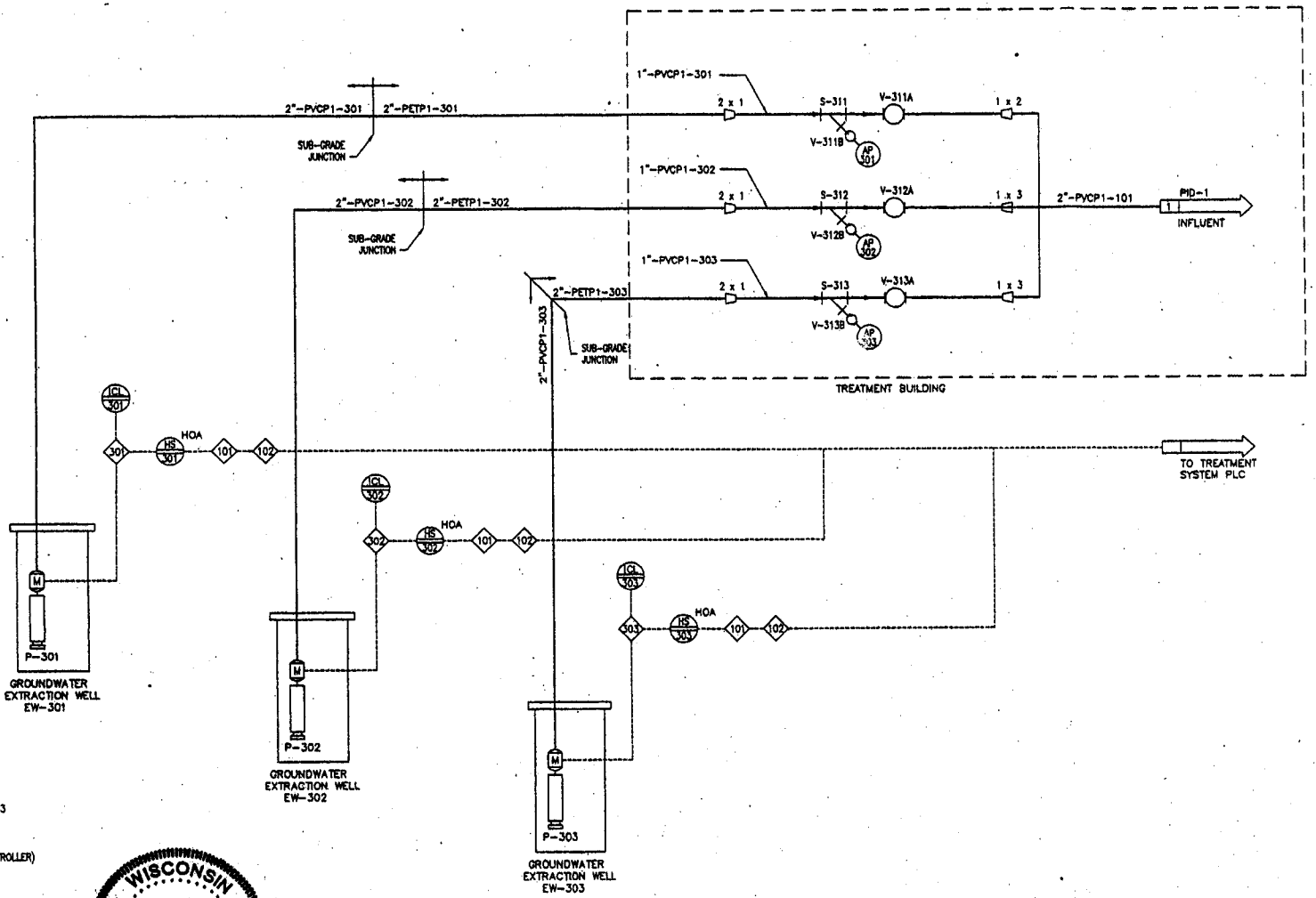
LANDFILL
DUNN, WISCONSIN

PIPING AND INSTRUMENTATION DIAGRAM

DRAWN	DATE	PROJECT MANAGER	CHECKED
WAY	9/16/99	JFORBORT	JFORBORT
		FILENAME	PLOT SCALE
		PID2.DWG	1:1
		PROJECT NUMBER	DRAWING NUMBER
		W1000743.0001	PID-2



INTERLOCK NOTES

- 101 GENERAL ALARM, SYSTEM TRIP
- 102 ENABLE/DISABLE P-301, P-302, P-303
- 301 ENABLE/DISABLE P-301 (COYOTE CONTROLLER)
- 302 ENABLE/DISABLE P-302 (COYOTE CONTROLLER)
- 303 ENABLE/DISABLE P-303 (COYOTE CONTROLLER)

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PROFESSIONAL ENGINEER

S-311, -312, -313	P-301	P-302	P-303
WYE STRAINER	GROUNDWATER EXTRACTION PUMP	GROUNDWATER EXTRACTION PUMP	GROUNDWATER EXTRACTION PUMP
TYPE: 1-INCH FNPT MATERIAL: BRASS BODY, SS FILTER SIZE: 40 MESH	TYPE: SUBMERSIBLE CAPACITY: <10 GPM MATERIAL: SS (ASSUMED) MODEL: GRUNDFOS (ASSUMED) 1/2 HP, 240 VAC, 1 Ph., 60 Hz.	TYPE: SUBMERSIBLE CAPACITY: <10 GPM MATERIAL: SS (ASSUMED) MODEL: GRUNDFOS (ASSUMED) 1/2 HP, 240 VAC, 1 Ph., 60 Hz.	TYPE: SUBMERSIBLE CAPACITY: <10 GPM MATERIAL: SS (ASSUMED) MODEL: GRUNDFOS (ASSUMED) 1/3 HP, 240 VAC, 1 Ph., 60 Hz.

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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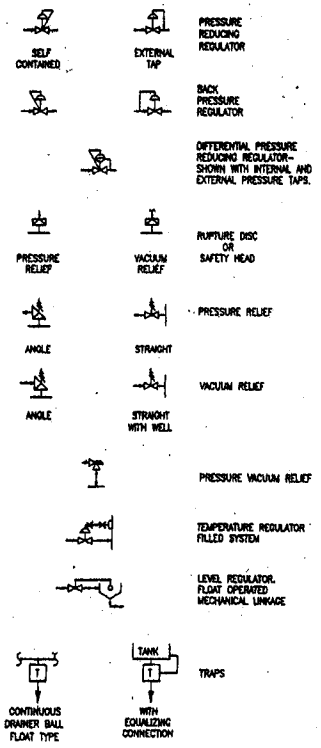
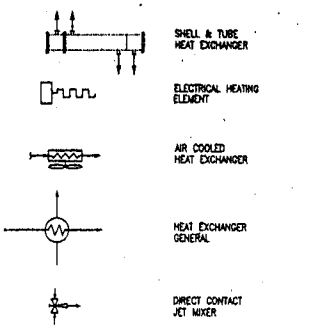
PIPING AND INSTRUMENTATION DIAGRAM

DRAWN	DATE	PROJECT MANAGER	CHECKED
WMAY	9/16/99	JFORBORT	JFORBORT
		FILENAME: PID3.DWG	PLOT SCALE: 1:1
		PROJECT NUMBER: WI000743.0001	DRAWING NUMBER: PID-3

SYMBOLS FOR SELF-ACTUATED REGULATORS

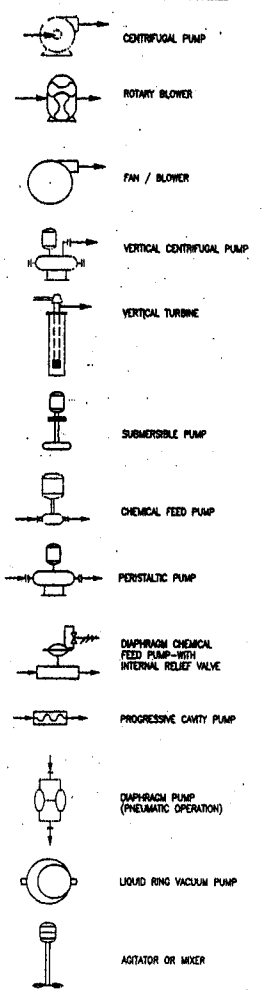


HEAT EXCHANGER SYMBOLS

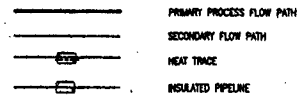


PRIME MOVERS FOR MOTOR DRIVEN EQUIPMENT

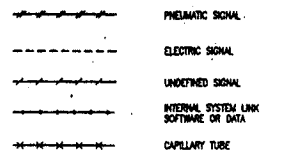
MOTOR DRIVEN EQUIPMENT



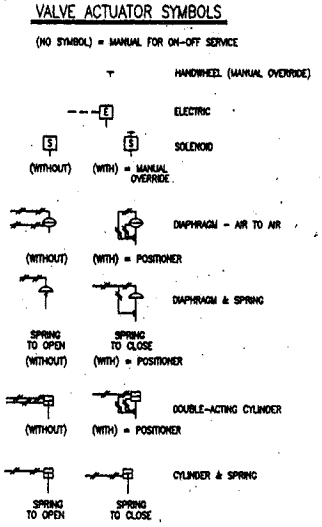
PIPING SYMBOLS



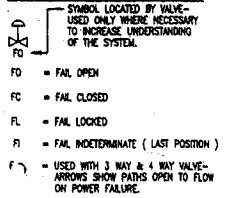
INSTRUMENT LINE SYMBOLS



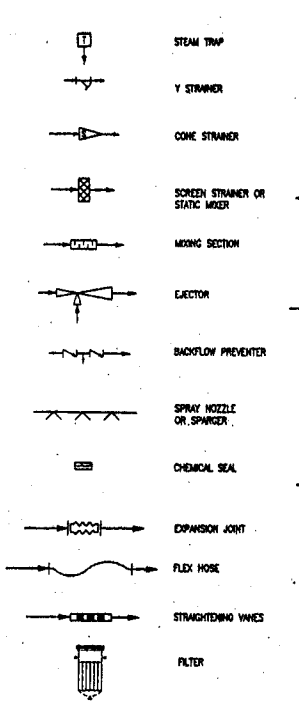
VALVE ACTUATOR SYMBOLS

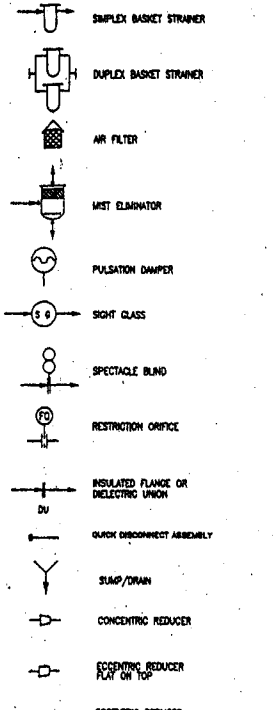


SYMBOLS FOR VALVE ACTION IN THE EVENT OF ACTUATOR POWER FAILURE.

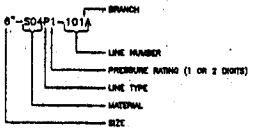


PIPING ACCESSORIES AND DETAILS





PIPE LINE DESIGNATION



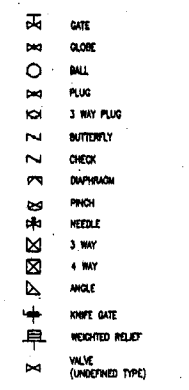
MATERIAL

BRZ = BRASS/BRONZE	PET = POLYETHYLENE
CIR = CAST IRON	POP = POLYPROPYLENE
CST = CARBON STEEL	PVC = POLYVINYL CHLORIDE
CPR = COPPER	RUB = RUBBER
FRP = FIBERGLASS	S04 = 304 STAINLESS STEEL
GCS = GALVANIZED CARBON STEEL	S4L = 304L STAINLESS STEEL
LCS = LINED CARBON STEEL	S16 = 316 STAINLESS STEEL
TEF = TEFLON	S8L = 316L STAINLESS STEEL
CVC = CHLORINATED POLYVINYL CHLORIDE	VIT = VITON

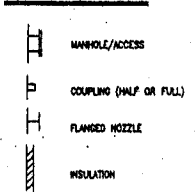
TYPE

D = DUCT P = PIPE
H = HOSE T = TUBE

VALVE SYMBOLS

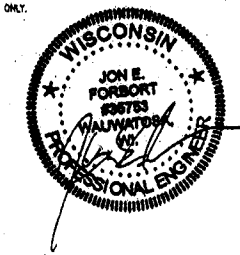


TANK ACCESSORIES



GENERAL NOTES:

1. THIS DRAWING IS PROVIDED FOR INFORMATION ONLY.



NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	2/03	AS-BUILT DOCUMENTATION	JF / JF

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WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

PIPING AND INSTRUMENTATION DIAGRAM LEGEND SHEET NO. 1

DRAWN	DATE	PROJECT MANAGER	CHECKED
MAY	9/16/99	JFORBORT	JFORBORT
		FILENAME PID4.DWG	PLOT SCALE 1:1
		PROJECT NUMBER WI000743.0001	DRAWING NUMBER PID-4

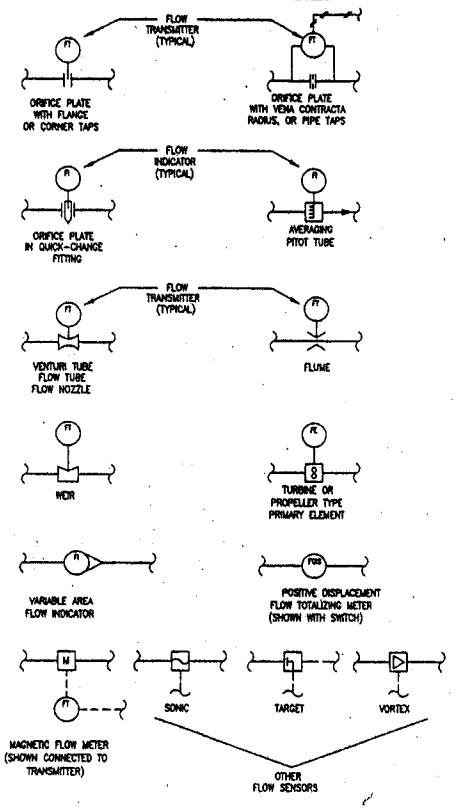
MISCELLANEOUS SYMBOLS

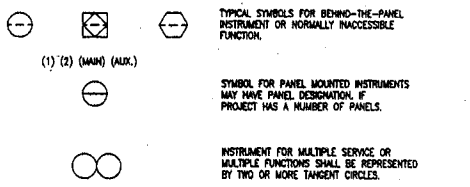
- INTEGRAL
- EXPONENTIAL
- NON LINEAR OR UNSPECIFIED FUNCTION
- TIME FUNCTION
- HIGH SELECTING
- LOW SELECTING
- ROOT EXTRACTION
- REVERSE
- DERIVATIVE
- ANALOG DIGITAL
- DIGITAL ANALOG
- CONVERT SIGNAL FORM (TYPICAL EXAMPLES)
  - E = VOLTAGE
  - H = HYDRAULIC
  - I = CURRENT
  - O = ELECTROMAGNATIC OR SONIC
  - P = PNUMATIC
  - R = RESTANCE (ELECTRICAL)
- REVERSE PROPORTIONAL
- BIAS
- PROPORTIONAL

NOTE: THE SQUARE MAY BE USED AS A FLAG.

- HAND-OFF-AUTO
- REVERSE ACTION
- PURGE OR FLUSHING DEVICE
- RESET FOR LATCH - TYPE ACTUATOR
- INTERLOCKING FUNCTIONS (GENERALIZED, AND, OR, SPECIFIC)
- (TYPICAL EXAMPLE SHOWS SQUARE ROOT EXTRACTOR IN FLOW LOOP.)

SYMBOLS FOR FLOW MEASUREMENT





(1) (2) (MAIN) (AUX.)

TYPICAL SYMBOLS FOR BEHIND-THE-PANEL INSTRUMENT OR NORMALLY INACCESSIBLE FUNCTION.

SYMBOL FOR PANEL MOUNTED INSTRUMENTS MAY HAVE PANEL DESIGNATION, IF PROJECT HAS A NUMBER OF PANELS.

INSTRUMENT FOR MULTIPLE SERVICE OR MULTIPLE FUNCTIONS SHALL BE REPRESENTED BY TWO OR MORE TANGENT CIRCLES.

INSTRUMENT IDENTIFICATION LETTERS

FIRST LETTER		SUCCEEDING LETTERS		
MEASURE OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A = ANALYSIS		ALARM		
B = BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C = USER'S CHOICE			CONTROL	
D = USER'S CHOICE	DIFFERENTIAL			
E = VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F = FLOW RATE	RATIO (FRACTION)			
G = USER'S CHOICE		GLASS, VIEWING DEVICE		
H = HAND				HIGH
I = CURRENT (ELECTRICAL)		INDICATE		
J = POWER	SCAN			
K = TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L = LEVEL		LIGHT		LOW
M = USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N = USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O = USER'S CHOICE		ORIFICE, RESTRICTION		
P = PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q = QUANTITY	INTERGRATE, TOTALIZE			
R = RADIATION		RECORD		
S = SPEED, FREQUENCY	SAFETY		SWITCH	
T = TEMPERATURE			TRANSMIT	
U = MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V = VIBRATION, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W = WEIGHT, FORCE		WELL		
X = UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y = EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z = POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

NOTES:
1. ANY FIRST LETTER COMBINED WITH MODIFIER REPRESENTS A NEW AND SEPARARE MEASURED VARIABLE. EXAMPLES: PD = DIFFERENTIAL PRESSURE FQ = TOTALIZED OR INTEGRATED FLOW. EXCEPTION IS THE MODIFIER "J" FOR MULTIPOINT SCANNING.
2. FOR ANALYSIS NOT IDENTIFIED BY A SPECIFIC LETTER IN THE TABLE, USE FIRST LETTER "A" NEAR THE INSTRUMENT SYMBOL, SPECIFY THE NATURE OF THE ANALYSIS. EXAMPLE: PH
3. MEANING OF A "USER CHOICE" LETTER SHALL BE CONSISTENT THROUGHOUT A PROJECT, AND SHALL BE SPECIFIED IN THE DRAWING LEGEND.
4. UNCLASSIFIED LETTER MAY HAVE A FEW DIFFERENT MEANINGS ON A PROJECT, THE MEANING SHALL BE SPCIFIED NEAR EACH INSTRUMENT SYMBOL USING THE UNCLASSIFIED LETTER.
5. THE MODIFIER "SCAN" APPLIES TO MULTIPOINT PRINTING INSTRUMENTS, SUCH AS CJRS (MULTIPOINT CONDUCTIVITY RECORDER WITH ALARM SWITCHES).

GENERAL NOTES:

1. THIS DRAWING IS PROVIDED FOR INFORMATION ONLY.

INSTRUMENT SYMBOLS

	PRIMARY CONTROL PANEL NORMALLY ACCESSIBLE TO OPERATOR	FIELD MOUNTED	AUXILIARY PANEL OR RACK NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS	⊖	○	⊖
SHARED DISPLAY, SHARED CONTROL	▭	▢	▭
COMPUTER FUNCTION INCLUDING DISTRB. CNTL. SYS.	⬡	⬡	⬡
PROGRAMMABLE LOGIC CONTROLLER FUNCTION	◇	◇	◇

WISCONSIN
JON E. FORBORT
#35753
WAUWATOSA WI
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

ARCADIS
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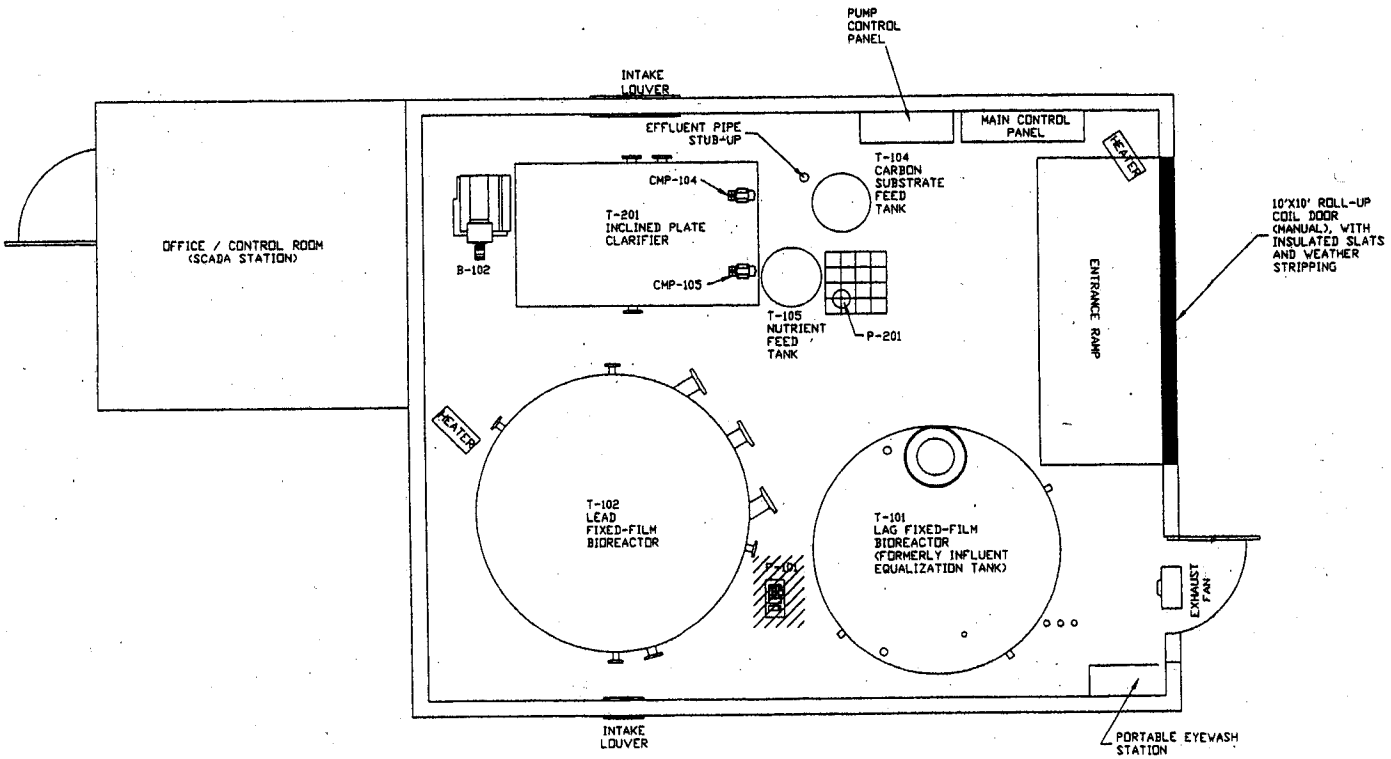
Suite 400, Milwaukee, Wisconsin 53202
Tel: 414/276-7742 Fax: 414/276-7603

WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

DRAWN	DATE	PROJECT MANAGER	CHECKED
WMY	5/16/99	JFORBORT	JFORBORT
		FILENAME PID5.DWG	PLOT SCALE 1:1
		PROJECT NUMBER	DRAWING NUMBER
		W000743.0001	PID-5

PIPING AND INSTRUMENTATION DIAGRAM LEGEND SHEET NO. 2



LEGEND

DENOTES EQUIPMENT AND/OR FUNCTION TAKEN OUT OF SERVICE DURING AUGUST 2002 RETROFIT.

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NO.	DATE	REVISION DESCRIPTION	BY
2	2/03	AS-BUILT DOCUMENTATION	JF
1	12/99	BIOREACTOR UPDATED	JEF

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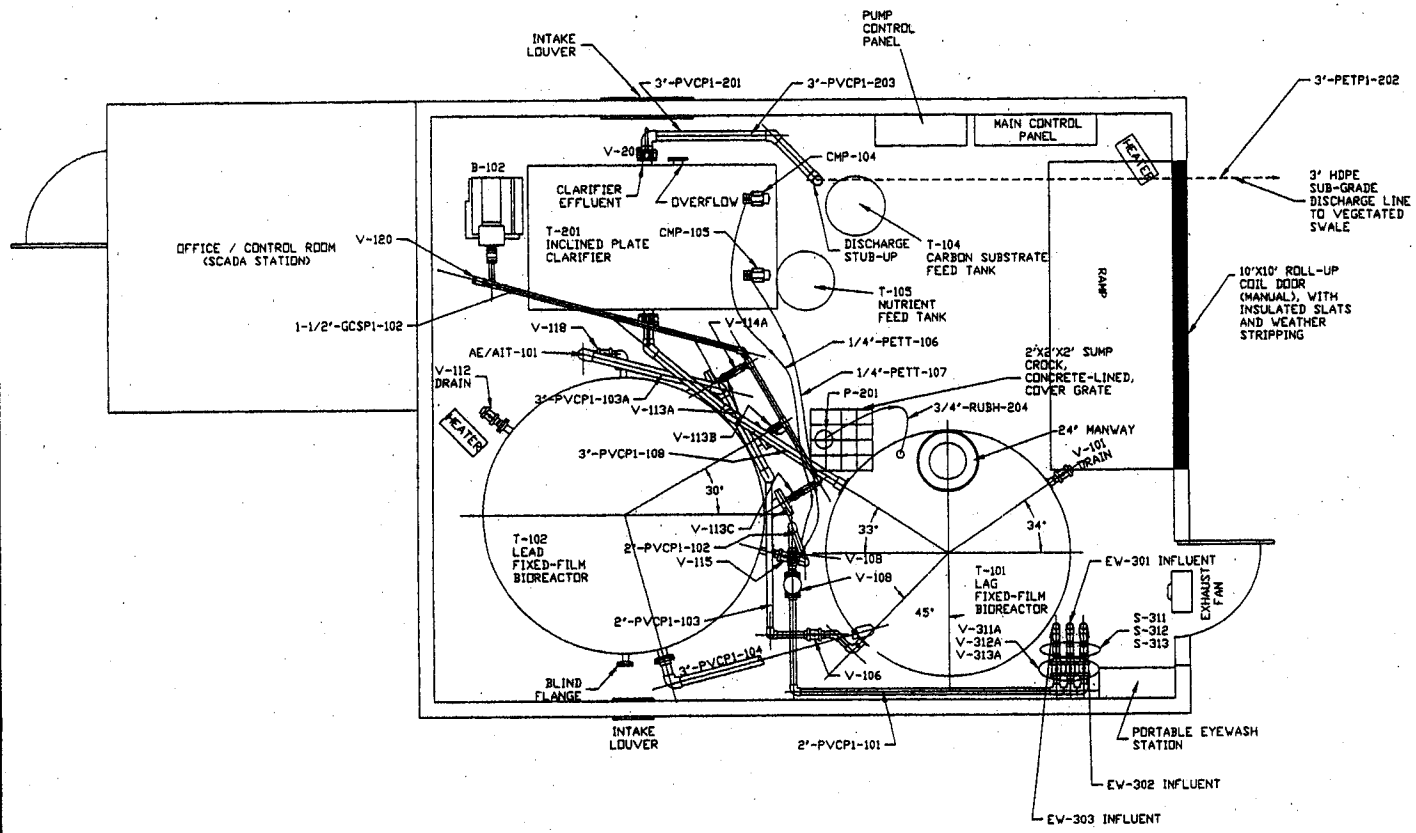
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

TREATMENT SYSTEM EQUIPMENT LAYOUT

DRAWN	DATE	PROJECT MANAGER	CHECKED
JCOTA	10/7/99	JFORBORT	JFORBORT
FILENAME: M-1.DWG		PLOT SCALE: 1/4"=1'	
PROJECT NUMBER: WI000743.0001		DRAWING NUMBER: M-1	



WISCONSIN
JON E. FORBORT
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WAUWATOSA, WI
PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
4	2/03	AS-BUILT DOCUMENTATION	JF	JF
3	3/00	CLARIFIER, PIPING	JEF	JEF
2	1/00	PIPING REVISIONS	JEF	JEF
1	12/99	BIOREACTOR, PIPING	JEF	MLP

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WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION LANDFILL
DUNN, WISCONSIN

TREATMENT SYSTEM
PIPING LAYOUT

DRAWN	DATE	PROJECT MANAGER	CHECKED
JDOTA	10/7/99	JFORBORT	JFORBORT
		FILENAME M-2.DWG	PLOT SCALE 1/4"=1'
		PROJECT NUMBER W10007430001	DRAWING NUMBER M-2

HVAC AND LIGHTING SCHEDULE

Item	Description	Mounting	Manufacturer & Part Number	Quantity	Remarks	Misc.
A	Light Fixtures, Treatment Building	Ceiling (Low Bay Type)	Lumark HPEP-R22-250-MT	4	250 Watt Low-Bay HPS Fixture (Replacement bulb: Osrdmpor /ZV713)	
B	Light Fixture, Outdoor Security	Wall	Lumark HPWB65125OUT	2	HPS Light Fixture, 250W, 120V, Equipped w/Wall Mount Ass'y.	
C	Light Fixture,Wall Mount, Door Light	Wall	Lumark HPWP-PC-70-120V-LL	1	HPS Light Fixture, 70W, 120V, Equipped w/Photoelectric Switch	
D	Emergency/Exit Lights	Wall	Sure-Light UNH-1-3WSH	1	Combination "exit" and emergency lighting fixtures	
E	Exhaust Fan Ass'y	Wall	Dayton 4C357	1	Exhaust Fan Assembly, Wall Mount, 1/4 HP 2400 ACFM, 18" Dia, Equipped w/Shutter	
F	Louver, Air Intake	Wall	Dayton 1C744	2	Aluminum Shutter, gravity actuated, 18" sq.	
G	Heater, Forced Air	Ceiling	Qtherk MUH-05-21MG	2	Heater, Forced Air Radiative, 5 KW, Use Kit, Bracket 6X946 and TStat 2C580	

ELECTRICAL LEGEND

- CONDUIT RUN (EXPOSED)
- GROUND BUS OR WIRE, TYPE & SIZE AS NOTED
- CONNECTION
- NO CONNECTION
- SEALTITE OR FLEXIBLE COND./CORD (AS DESCRIBED IN SPEC)
- LIGHTNING ARRESTOR(S)
- WYE, 3 PHASE, GROUNDED
- GROUND CONNECTION
- GROUND ROD
- MOTOR STARTER, F.V.N.R. TYPE
- FUSE, AMPERE RATING AS SHOWN
- UNIT OR SPACE HEATER(AS DESC. IN SPEC. (LAYOUT DRAWING))
- UNIT OR SPACE HEATER (SINGLE LINE DRAWING)
- (0.5) INDUCTION MOTOR, (SINGLE LINE) # DENOTES H.P.
- (1.0) INDUCTION MOTOR, (ELECTRICAL LAYOUT), # DENOTES H.P.
- T THERMOSTAT
- A HVAC/LIGHTING DEVICE (SEE SCHEDULE)
- LIGHTING FIXTURE (SODIUM VAPOR/METAL HALIDE)
- LIGHTING FIXTURE (FLOURESCENT)
- DUPLEX RECEPTACLE (#-# DENOTES PANEL "A" CIRCUIT #)
- CURRENT TRANSFORMER
- POWER TRANSFORMER
- JB-- JUNCTION BOX
- WHM WATTHOUR METER
- RGS RIGID GALVANIZED STEEL
- WP WEATHER PROOF
- C-X CONTROL CONDUIT
- P-X POWER CONDUIT (120/240)
- I-X INSTRUMENTATION CONDUIT
- TM THERMAL-MAGNETIC
- UH UNIT HEATER
- MCP MAIN CONTROL PANEL
- MCC MOTOR CONTROL CENTER
- AWG AMERICAN WIRE GAUGE
- PVC POLYVINYL CHLORIDE
- S.N. SERVICE NEUTRAL
- EMERGENCY LIGHTS
- LA LIGHTNING ARRESTOR
- DISCONNECT (MECHANICAL)

CONDUIT AND CONDUCTOR SCHEDULE

Conduit	Service	Purpose	Conduit Size and Type	Number of Conductors and Size of Conduit (Note 1)	Run Location From	Run Location To	Layout Location	Comment
P-1	240V Main	Main Utility Service Entrance	2" RGS	(3) #3/0 AWG THHN/THWN	WEATHERHEAD	UTILITY METER/DISCONNECT	MAIN BLDG.	(Note 1)
P-2	240V Main	Main Power Feed	2" RGS	(3) #3/0 AWG THHN/THWN	DISCONNECT DSC-1	MAIN POWER PANEL PNL-1	MAIN BLDG.	
P-3	240V Power	Power Feed for P-301 & P-302 Controller	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	PNL-1	PUMP CONTROL PANEL (P-C)	MAIN BLDG.	(Note 1,2,4)
P-4	240V Power	Power Feed for P-301 & P-302 Pumps	1 1/2" RGS/PVC	(4) #8 AWG + (2) #8 AWG Gnd.	P-C	JB-P2	MAIN BLDG. / VLT.	(Note 1,2,4)
P-5	240V Power	Power Feed to B-102 Motor Starter	1" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	PNL-1	B-102 STARTER	MAIN BLDG.	(Note 1,2,3)
P-6	240V Power	B-102 Power Feed	3/4" Liquidtight Flex/RGS	(2) #12 AWG + (1) #12 AWG Gnd.	B-102 STARTER	BLOWER B-102	MAIN BLDG.	(Note 1)
P-7	240V Power	Power Feed to P-101 Motor Starter	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	PNL-1	P-101 STARTER	MAIN BLDG.	(Note 2)
P-8	240V Power	P-101 Power Feed	3/4" Liquidtight Flex/RGS	(2) #12 AWG + (1) #12 AWG Gnd.	P-101 STARTER	PUMP P-101	MAIN BLDG.	(Note 1)
P-9	240V Power	Power Feed to UH-1 Heater	3/4" Liquidtight Flex/RGS	(2) #10 AWG + (1) #10 AWG Gnd.	PNL-1	UH-1 HEATER	MAIN BLDG.	(Note 2)
P-10	240V Power	Power Feed to Exhaust Fan Contactor	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	PNL-1	VF-1 CONTACTOR	MAIN BLDG.	
P-11	240V Power	Exhaust Fan Power Feed	3/4" Liquidtight Flex/RGS	(2) #12 AWG + (1) #12 AWG Gnd.	VF-1 CONTACTOR	VENT FAN VF-1	MAIN BLDG.	
P-12	120V Power	Main Control Panel (MCP) Power	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	PNL-1	MAIN CONTROL PANEL (MCP)	MAIN BLDG.	
P-13	120V Power	CMP-104 Power	Utility Cord w/Plug	(2) #14 AWG + (1) #14 AWG Gnd.	JB-P1	CMP-104	MAIN BLDG.	
P-14	120V Power	CMP-105 Power	Utility cord w/Plug	(2) #14 AWG + (1) #14 AWG Gnd.	JB-P1	CMP-105	MAIN BLDG.	
P-15	120V Power	P-301 Power Feed	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	MCP	SUMP PUMP P-301	MAIN BLDG.	
P-16	240V Power	Power Feed to UH-1 Heater	3/4" Liquidtight Flex/RGS	(2) #10 AWG + (1) #10 AWG Gnd.	PNL-1	UH-1 HEATER	MAIN BLDG.	
P-17	120V Power	CMP 104 & 105 Power Feed	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	MCP	JB-P1	MAIN BLDG.	
P-18	120V Power	FE/FIT-101 Power Feed	3/4" RGS	(2) #12 AWG + (1) #12 AWG Gnd.	MCP	JB-P1	MAIN BLDG.	

Conduit	Service	Purpose	Conduit Size and Type	Number and types of Conductor(s)	Run Location From	Run Location To	Layout Location	Comment
C-1	120V Control	MCP to Blower B-102 Motor Starter Control	3/4" RGS	(8) #16 AWG MTW	MCP	Motor Starter MS-B-102	MAIN BLDG.	
C-2	120V Control	MCP to Pump P-101 Motor Starter Control	3/4" RGS	(8) #16 AWG MTW	MCP	Motor Starter MS-P-101	MAIN BLDG.	
C-3	120V Control	Tank T-101 Level Controls	3/4" RGS	(12) #14 AWG THHN/THWN (4 spares)	MCP	JB-C1	MAIN BLDG.	
C-4	120V Control	JB-C2 Home Run Recevoy	3/4" RGS	(20) #14 AWG THHN/THWN (8 spares)	MCP	JB-C2	MAIN BLDG.	
C-5	120V Control	Control Valve FV-118 Control	1" RGS/Liquidtight Flex	(8) #14 AWG THHN	JB-C2	FV-118	MAIN BLDG.	
C-6	120V Control	Control Valve FV-107 Control	1" RGS/Liquidtight Flex	(8) #12 AWG, THHN	JB-C2	FV-107	MAIN BLDG.	
C-7	120V Control	Bioreactor Level Switches	3/4" RGS/Liquidtight Flex	(6) #14 MTW (2 Spares)	JB-C2	LS-106/LSHL-108	MAIN BLDG.	
C-8	120V Control	Tank T-101 Level Controls	3/4" RGS/Liquidtight Flex	(8) #14 MTW	JB-C1	T-101 LEVEL SWITCHES	MAIN BLDG.	
C-9	120V Control	JB-C3 Home Run Recevoy	3/4" RGS	(8) #14 AWG THHN/THWN (4 spares)	MCP	JB-C3	MAIN BLDG.	
C-10	120V Control	Pressure Switch PS-102 Control	3/4" RGS	(2) #14 AWG THHN/THWN	JB-C3	PS-102	MAIN BLDG.	
C-11	120V Control	Temp. Switch TS-102 Control	3/4" RGS	(2) #14 AWG THHN/THWN	JB-C3	TS-102	MAIN BLDG.	
C-12	120V Control	Floor Sump Level Switch Control	3/4" RGS	(6) #14 AWG THHN/THWN (2 spares)	JB-C3	PS-102	MAIN BLDG.	
C-13	120V Control	Floor-Mounted E-Stop	3/4" RGS	(2) #14 AWG THHN/THWN (2 spares)	JB-C1	E-STOP	MAIN BLDG.	
C-14	120V Control	P-303 Control	1-1/2" RGS	(12) #14 AWG THHN/THWN (4 spares)	P-1	JB-C4	MAIN BLDG. / VLT.	

Conduit	Service	Purpose	Conduit Size and Type	Number of Conductors and Size of Conduit	Run Location From	Run Location To		Comments
I-1	4-20 mA	JB-I1 Home Run Recevoy	1" RGS	(6) #20 AWG Shielded Pairs (Belden 9243) + (4) #14 AWG THHN	MCP	JB-I1	MAIN BLDG.	
I-2	4-20 mA	Temperature Element TE/TIT-101 Signal	3/4" RGS/Liquidtight Flex	(1) #20 AWG Shielded Pair (Belden 9243)	JB-I1	TE-101	MAIN BLDG.	
I-3	4-20 mA	pH Element AE-101 Signal	3/4" RGS/Liquidtight Flex	(1) #20 AWG Shielded Pair (Belden 9243)	JB-I1	AE-101	MAIN BLDG.	
I-4	4-20 mA	Flowmeter FE/FIT-101 Signal	3/4" RGS/Liquidtight Flex	(1) #20 AWG Shielded Pair (Belden 9243) + (4) #14 AWG THHN	JB-I1	FE-101	MAIN BLDG.	
I-5								

NOTE:

1. MAIN 200 AMP SERVICE TRANSMITTED OVERHEAD TO PROPOSED TREATMENT BUILDING. UTILITY METER AND MAIN 200 AMP FUSED DISCONNECT MOUNTED OUTSIDE PROPOSED BUILDING.
2. CONNECTIONS TO TO P-101, B-102, VF-1 AND UNIT HEATERS SHALL BE MADE USING FLEXIBLE CONNECTIONS FOR VIBRATION ISOLATION.
3. EXISTING WELL PUMP CONTROLLER SHALL BE RELOCATED FROM EXISTING BUILDING TO PROPOSED BUILDING. P-301 AND P-302 POWER FEEDS SHALL BE ROUTED THROUGH JUNCTION BOX (JB-P2) TO BE INSTALLED IN A VAULT TO BE CONSTRUCTED AT THE LOCATION OF THE EXISTING TREATMENT SHED. P-303 CONTROL WIRING SHALL BE ROUTED THROUGH VAULT JUNCTION BOX (JB-C4).
4. UNDERGROUND RACEWAYS MAY UTILIZE SCHEDULE 80 PVC CONDUIT, PROVIDED THAT CONDUIT TRANSITIONS TO RIGID GALVANIZED STEEL AT LEAST 10 LINEAR FEED PRIOR TO PENETRATING UPWARD THROUGH FINISHED GRADE.
5. CONNECTIONS TO ALL INSTRUMENTATION AND SWITCHES SHALL UTILIZE FLEXIBLE MEANS OF CONNECTING POWER, CONTROL AND SIGNAL WIRING TO THE DEVICE.

WISCONSIN JON E. FORBORT #35753 WAUWATOSA, WI PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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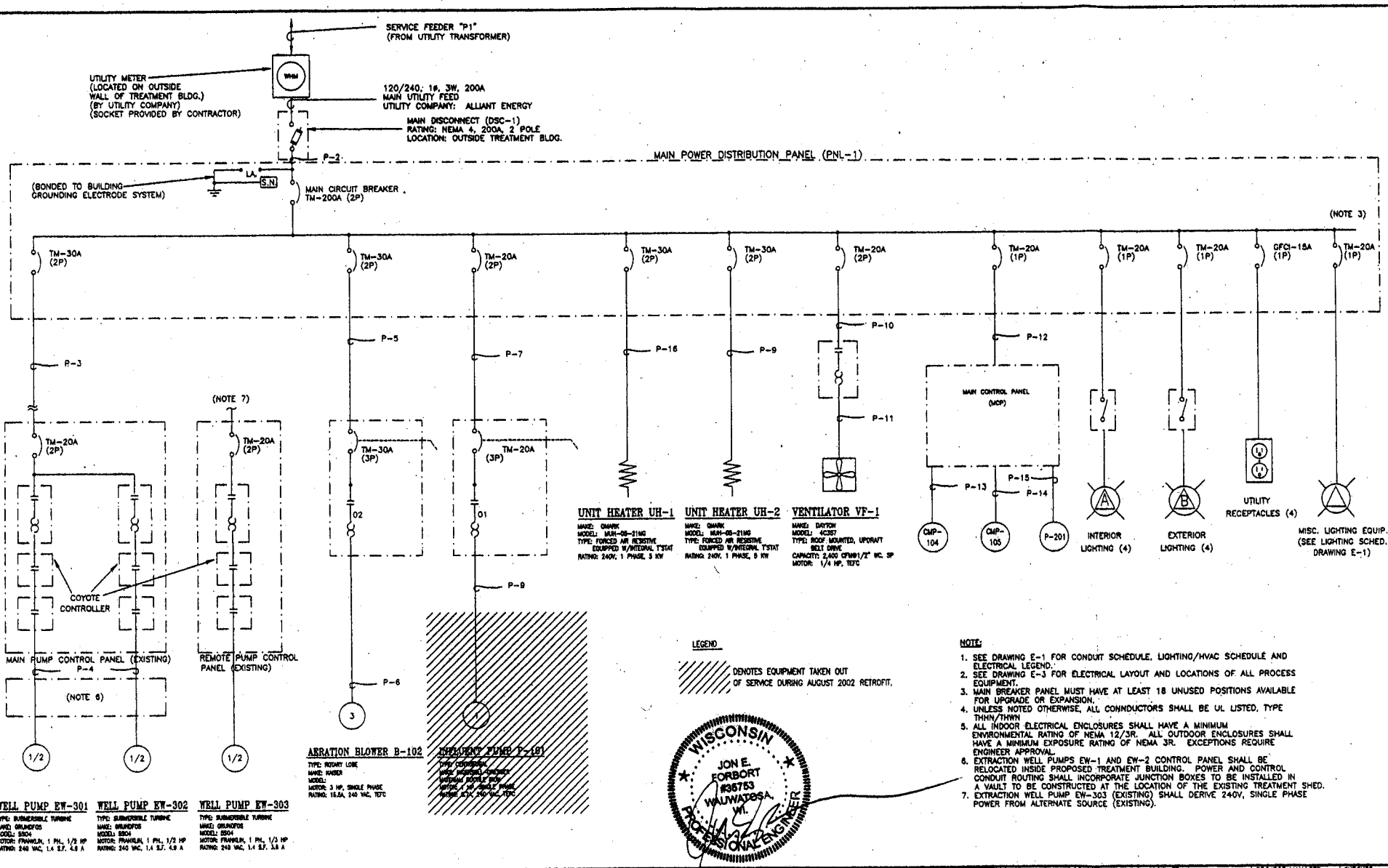
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

ELECTRICAL LEGEND AND CONDUIT SCHEDULE

DRAWN	DATE	PROJECT MANAGER	CHECKED
CMCHALE	11/10/99	JFORBORT	JFORBORT
		FILENAME E-1.DWG	PLOT SCALE 1:1
		PROJECT NUMBER W1000743.0001	DRAWING NUMBER E-1



LEGEND

DENOTES EQUIPMENT TAKEN OUT OF SERVICE DURING AUGUST 2002 RETROFIT.

NOTE:

1. SEE DRAWING E-1 FOR CONDUIT SCHEDULE, LIGHTING/HVAC SCHEDULE AND ELECTRICAL LEGEND.
2. SEE DRAWING E-3 FOR ELECTRICAL LAYOUT AND LOCATIONS OF ALL PROCESS EQUIPMENT.
3. MAIN BREAKER PANEL MUST HAVE AT LEAST 18 UNUSED POSITIONS AVAILABLE FOR UPGRADE OR EXPANSION.
4. UNLESS NOTED OTHERWISE, ALL CONNDUCTORS SHALL BE UL LISTED, TYPE THHN/THWN
5. ALL INDOOR ELECTRICAL ENCLOSURES SHALL HAVE A MINIMUM ENVIRONMENTAL RATING OF NEMA 12/3R. ALL OUTDOOR ENCLOSURES SHALL HAVE A MINIMUM EXPOSURE RATING OF NEMA 3R. EXCEPTIONS REQUIRE ENGINEER APPROVAL.
6. EXTRACTION WELL PUMPS EW-1 AND EW-2 CONTROL PANEL SHALL BE RELOCATED INSIDE PROPOSED TREATMENT BUILDING. POWER AND CONTROL CONDUIT ROUTING SHALL INCORPORATE JUNCTION BOXES TO BE INSTALLED IN A VAULT TO BE CONSTRUCTED AT THE LOCATION OF THE EXISTING TREATMENT SHED.
7. EXTRACTION WELL PUMP EW-303 (EXISTING) SHALL DERIVE 240V, SINGLE PHASE POWER FROM ALTERNATE SOURCE (EXISTING).

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WASTE MANAGEMENT INC.
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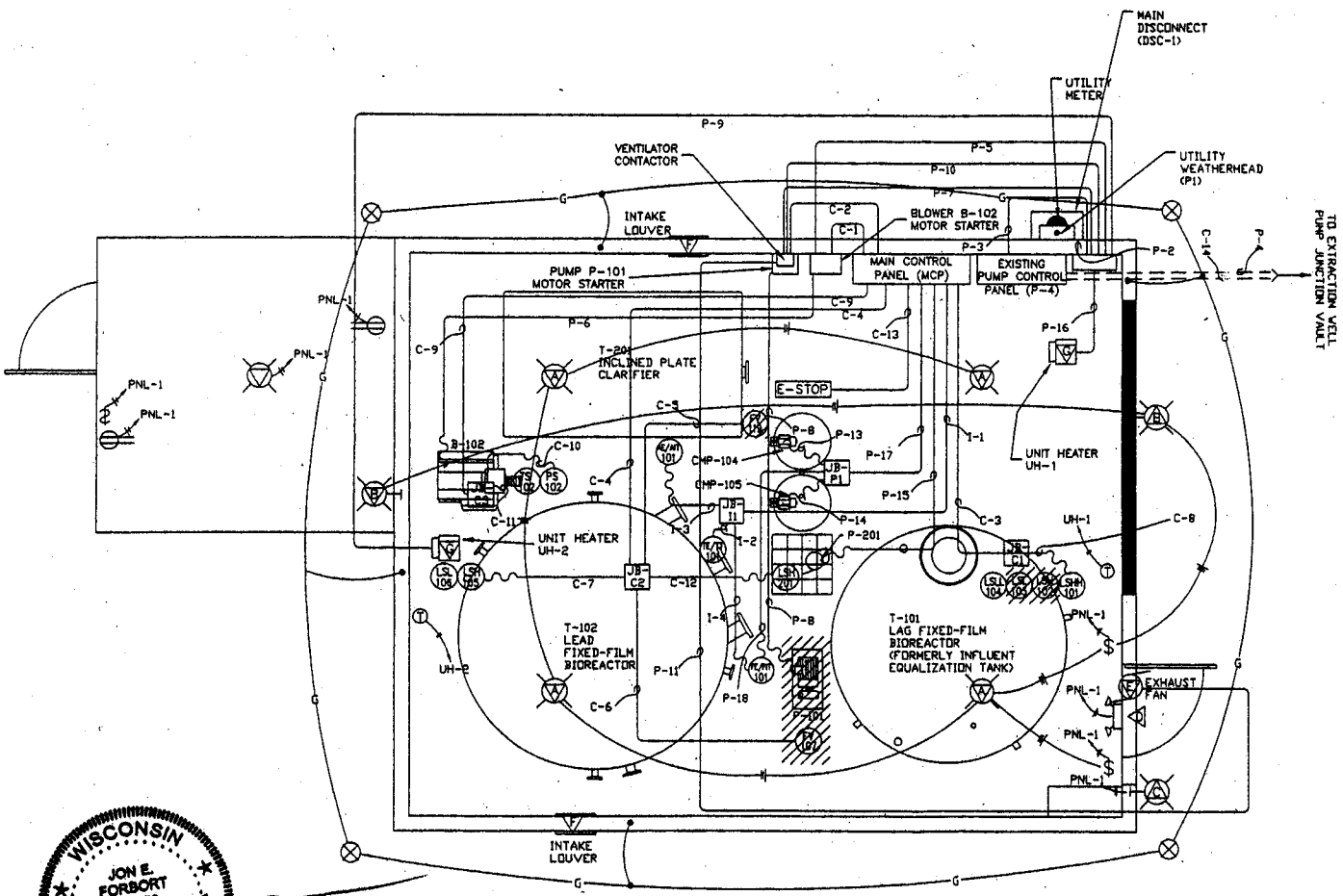
LANDFILL
DUNN, WISCONSIN

ELECTRICAL ONE-LINE DIAGRAM

DRAWN	DATE	PROJECT MANAGER	CHECKED
CMcHALE	11/10/99	JFORBORT	JFORBORT
		FILENAME E-2.DWG	PLOT SCALE 1:1
		PROJECT NUMBER W1000743.0001	DRAWING NUMBER E-2



LEGEND

DENOTES EQUIPMENT AND/OR FUNCTION TAKEN OUT OF SERVICE DURING AUGUST 2002 RETROFIT.

JON E. FORBORT #35753 WAUWATOSA WI PROFESSIONAL ENGINEER

NO.	DATE	REVISION DESCRIPTION	BY	CKD
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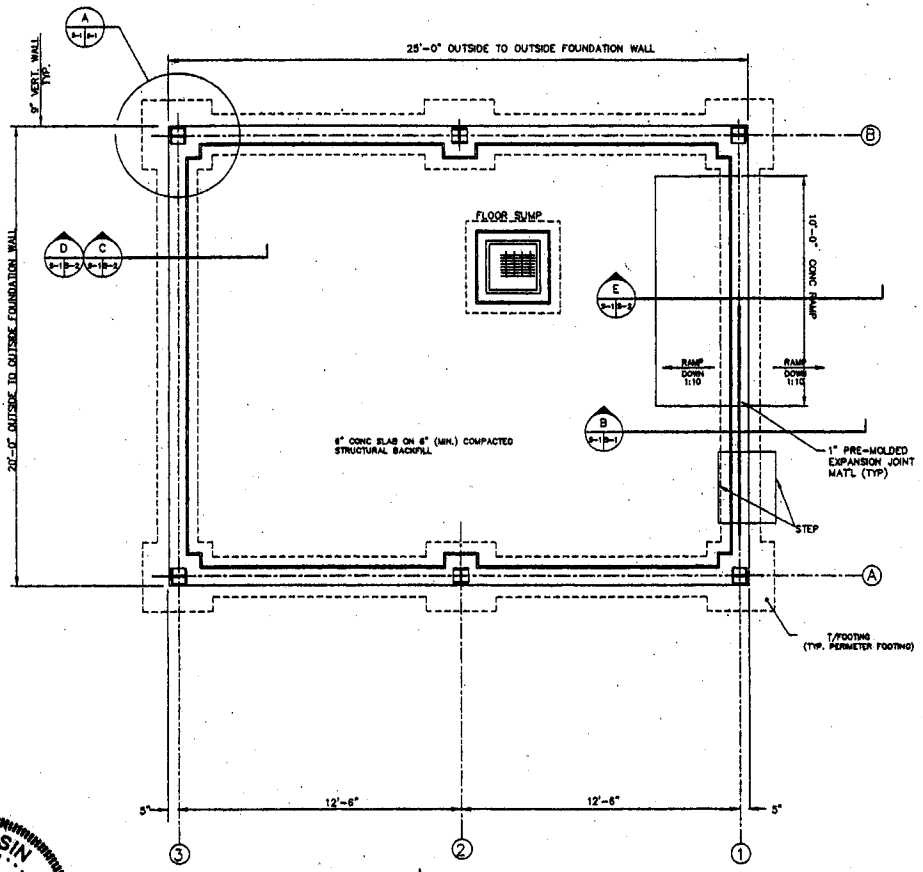
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

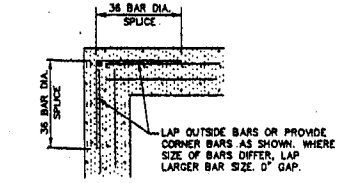
ELECTRICAL LAYOUT PLAN

DRAWN	DATE	PROJECT MANAGER	CHECKED
JCOTA / CMCHALE	10/2/98	JFORBORT	JFORBORT
		FILENAME E-3.DWG	PLOT SCALE 1/4"=1'
		PROJECT NUMBER W1000743.0001	DRAWING NUMBER E-3



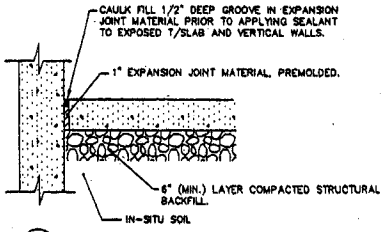
TYPICAL FOUNDATION LAYOUT – PLAN

SCALE: 3/8" = 1'-0"



A CORNER BAR REINF. – PLAN

N.T.S.



B TYPICAL EXPANSION JOINT – ELEV.

N.T.S.

CONCRETE NOTES:

1. ALL CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF ACI 318-83 AND ACI 301-84.
2. EXCEPT WHERE OTHERWISE INDICATED, CONCRETE TYPES AND MINIMUM 28-DAY COMPRESSIVE STRENGTHS SHALL BE AS FOLLOWS:

   SLAB ON GRADE = 4000 PSI REGULAR WEIGHT.
   FOUNDATION WALLS = 4000 PSI REGULAR WEIGHT.

DESIGN LOADS:

1. FOUNDATION DESIGN IS BASED ON AN ALLOWABLE SOIL BEARING PRESSURE OF 3000 PSF.
2. THE SLAB-ON-GRADE IS DESIGNED FOR A FLOOR LOAD OF 500 PSF.

WISCONSIN JON E. FORBORT #35753 WAUWATOSA PROFESSIONAL ENGINEER

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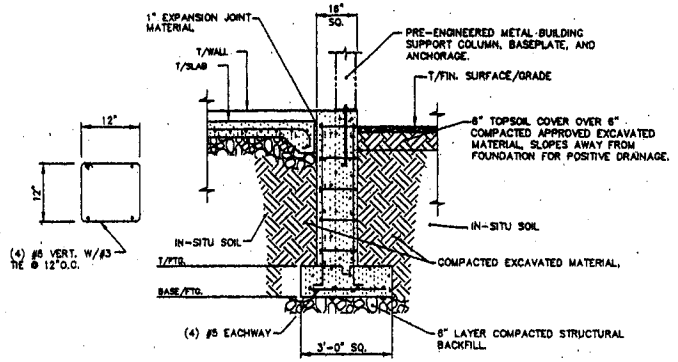
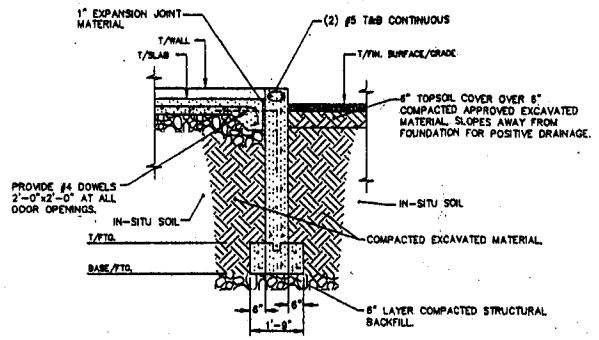
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

TREATMENT BUILDING FOUNDATION PLAN

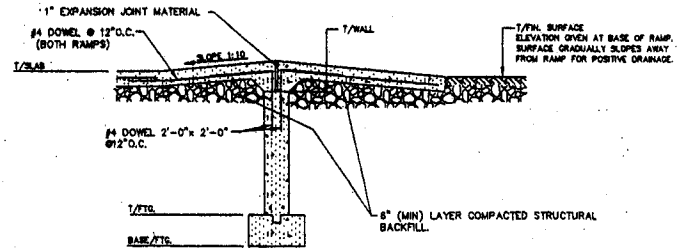
DRAWN	DATE	PROJECT MANAGER	CHECKED
JCDTA	10/26/89	JFORBORT	JFORBORT
		FILENAME S-1.DWG	PLOT SCALE 3/16"=1'-0"
		PROJECT NUMBER WI0007430001	DRAWING NUMBER S-1



C TYPICAL COLUMN PIER AND FOOTING
N.T.S.



D TYPICAL FOUNDATION WALL
N.T.S.



E TYPICAL RAMP CONSTRUCTION DETAIL - ELEV.
N.T.S.

WISCONSIN
JON E. FORBORT
#35753
WAUWATOSA, WI
PROFESSIONAL ENGINEER

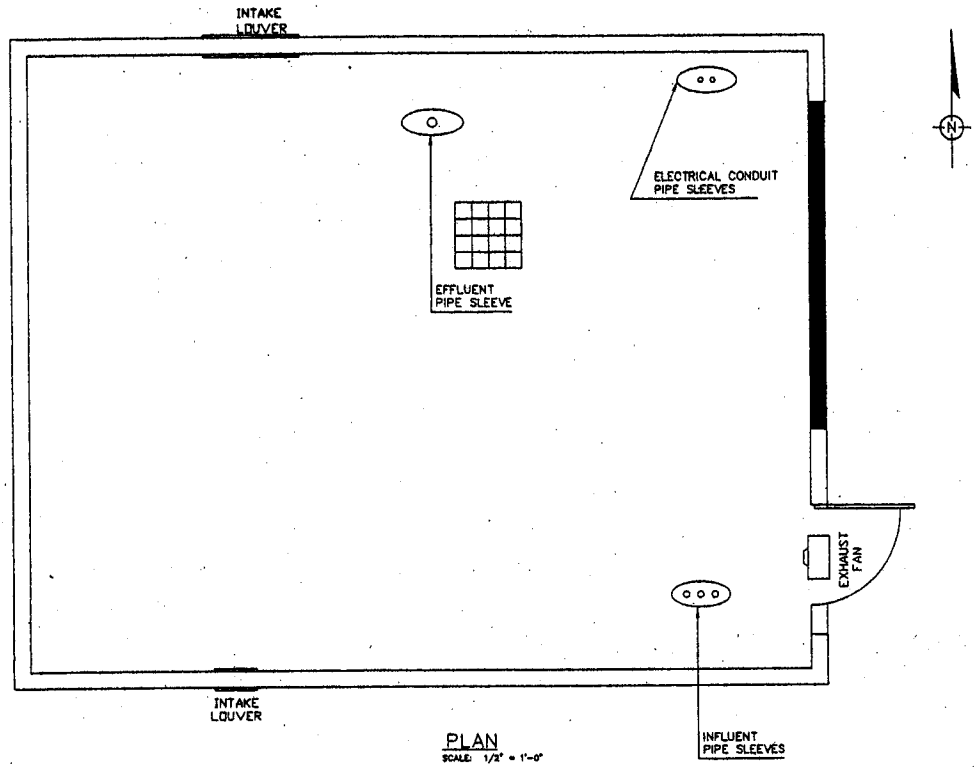
NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

ARCADIS
126 North Jefferson Street
Suite 400, Milwaukee, Wisconsin 53202
Tel: 414/276-7742 Fax: 414/276-7603

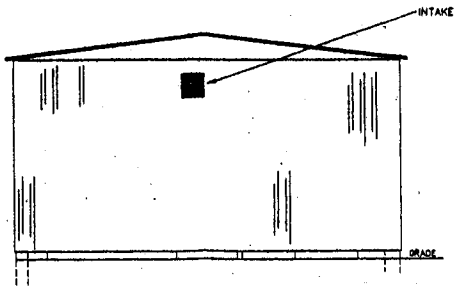
WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

TREATMENT BUILDING FOUNDATION DETAILS

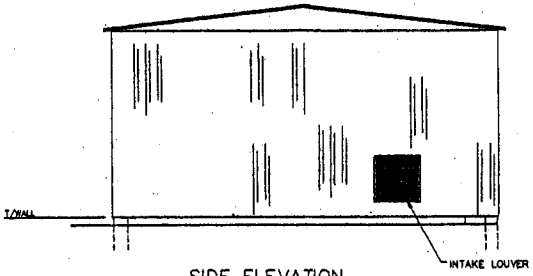
DRAWN	DATE	PROJECT MANAGER	CHECKED
JCOTA	10/28/99	JFORBORT	JFORBORT
		FILENAME S-2.DWG	PLOT SCALE 1/4"=1'
		PROJECT NUMBER WI0007430001	DRAWING NUMBER S-2



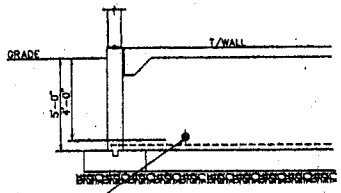
PLAN
SCALE: 1/2" = 1'-0"



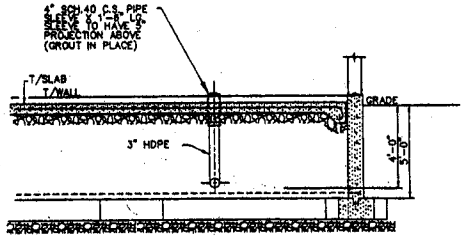
SIDE ELEVATION
SCALE: 1/4" = 1'-0"



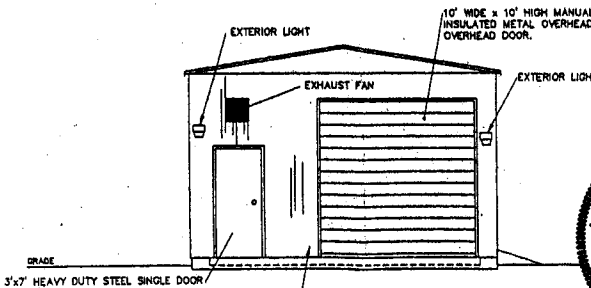
SIDE ELEVATION
SCALE: 1/4" = 1'-0"



PIPE PENETRATIONS DETAIL
N.T.S.



PIPE PENETRATIONS DETAIL
N.T.S.



PRE-ENGINEERED INSULATED METAL BUILDING COMPLETE WITH ROOF FLASHING FOR VENT PIPE PENETRATION(s), ANCHORAGE, AND SPECIFIED DOORS, VENTS, LIGHTS AND EXHAUST FAN.

EAST ELEVATION
SCALE: 1/4" = 1'-0"

NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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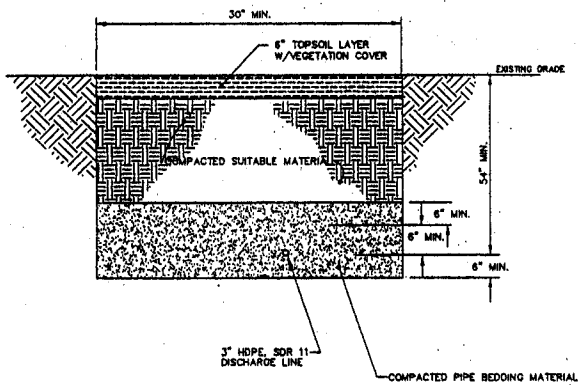
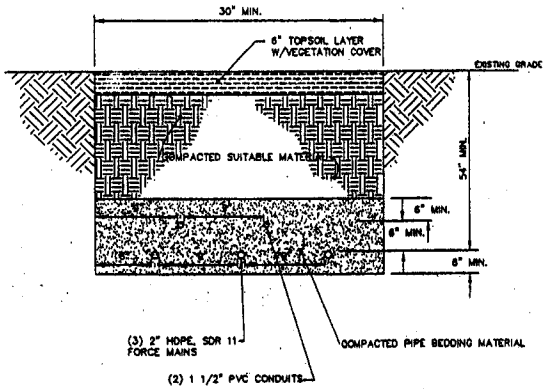
LANDFILL
DUNN, WISCONSIN

TREATMENT BUILDING - PLAN/ELEVATIONS

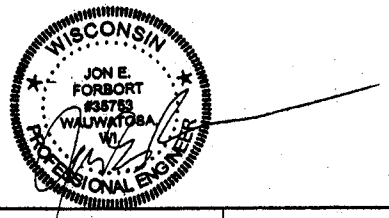
DRAWN	DATE	PROJECT MANAGER	CHECKED
JCOTA	10/26/99	JFORBORT	JFORBORT
		FILENAME: WASTE/WI0743/TREAT_SYS/CAD	PLOT SCALE: 3/16"=1'
		PROJECT NUMBER: WI0007430001	DRAWING NUMBER: S-3



TREATMENT SYSTEM DISCHARGE TRENCH DETAIL
N.T.S.



FORCE MAIN TRENCH DETAIL
N.T.S.



NO.	DATE	REVISION DESCRIPTION	BY	CKD
1	2/03	AS-BUILT DOCUMENTATION	JF	JF

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WASTE MANAGEMENT INC.
CITY DISPOSAL CORPORATION
LANDFILL
DUNN, WISCONSIN

TRENCH DETAILS

DRAWN	DATE	PROJECT MANAGER	CHECKED
JCOTA	10/29/99	JFORBORT	JFORBORT
		FILENAME: WASTE/WI0743/TREAT_SYS/CAD	PLOT SCALE: 3/8"=1'
		PROJECT NUMBER: WI0007430001	DRAWING NUMBER: S-4